

ANNUAL REPORT

1959

RUBBER RESEARCH INSTITUTE OF MALAYA

Corrections

1958 Annual Report

Page

- 3 *Add* The Director, Mr C. E. T. Mann, was on leave from
12 April to 18 November.
- 32 *Line 31, for n read 2n*
- 38 *Line 25, for S/2.d/4.100% read S/2.d/2.100%.*
- 41 *Line 15, for IAA (c.lg/ml) read IAA (c.l μ g/ml)*
- 46 *Line 7, for a clone of Hevea benthamiana read another
Hevea brasiliensis clone selected in Brazil for disease
resistance.*

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1959

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RUBBER RESEARCH INSTITUTE OF MALAYA

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CONTENTS

	Rep. Rubb. Res. Inst. Malaya
REPORT OF THE BOARD	3
REPORT OF THE DIRECTOR	6
SOILS DIVISION	17
Research	17
Advisory	30
BOTANICAL DIVISION	32
Research	35
Advisory	54
<i>Appendix</i>	58
PATHOLOGICAL DIVISION	60
Research	60
Advisory	65
CHEMICAL DIVISION	67
Fundamental Research	68
Applied Research	75
Process Evaluation and Factory Studies	79
Advisory and Technical Services	84
SMALLHOLDERS' ADVISORY SERVICE	90
Advisory	93
Information and Education	103
<i>Appendix</i>	108
ESTATES ADVISORY SERVICE	112
PUBLICATIONS AND INFORMATION	118
R.R.I. EXPERIMENT STATION	120
<i>Appendix</i>	128
Senior Staff and Graduate Assistants	128
Accounts	131
Map (folding): Experiment Station, Sungei Buloh	

The Rubber Research Institute of Malaya

The Institute was established under the Rubber Research Institute of Malaya Enactment 1925, amended in 1934. It was founded for the purpose of research into rubber production in all its aspects and for the provision of information on the results of research. Funds are provided by a voluntary cess on the exports of rubber from Malaya. Contributions are also received from other producing territories—Nigeria, Sarawak, Brunei and North Borneo. The Institute is administered by a board consisting of Government nominees and selected representatives from planting organisations.

Three Divisions, Soils, Botanical and Pathological, are concerned with the cultivation of the rubber tree and the harvesting of the crop. The Chemical Division carries out investigations into the conversion of the crop into marketable forms. There is also a Statistical Section and a Publications and Information Section which includes the Library.

The Smallholders' Advisory Service has the task of conveying the results of research to the large rubber smallholding community of Malaya. An Estates Advisory Service has also been formed which will provide routine advice to all estates, that is all planted areas over 100 acres.

The main research buildings are at Kuala Lumpur. The Experiment Station, about 3,000 acres in extent, is at Sungei Buloh, 16 miles from Kuala Lumpur.

Report of the Board

At the end of the year, the members of the Board, under its Constitution as prescribed by the R.R.I. Enactment No. 14 of 1934, were:

- a. The Director of the Institute (Mr C. E. T. Mann), Chairman
- b. The Assistant Secretary to the Treasury (Mr Lim Kim Cheng, M.C.S.).
- c. The Director of Agriculture (Mr A. L. Barcroft).
- d. Members appointed to represent the interests of the Smallholders:
The Hon'ble Enche Abdul Jalil bin Haji Aminudin, P.J.K., J.P.
The Hon'ble Mr Yap Kim Hock, J.P.
- e. Members appointed from a panel nominated jointly by the Rubber Growers' Association, the United Planting Association of Malaya and the Malayan Estate Owners' Association:
Mr A. W. Goode
Mr. J. C. Mathison, O.B.E. P.J.K.
Mr J. Brown
Mr S. Sandison
The Hon'ble Mr Choo Kok Leong

Mr Lim Kim Cheng, M.C.S., Assistant Secretary to the Treasury, succeeded Mr C. L. Robless as Financial Member on the Board and on the Permanent Committee from 21 April 1959.

The Acting Director of Agriculture, Mr P. G. Coleman, left Malaya on retirement on 14 June and Mr A. L. Barcroft was appointed to act in his place.

The Hon'ble Mr A. W. Good was on leave from 7 April to 3 August and Mr Soon Cheng Sun, J.P., was appointed to act for him during his absence.

The Director of the Institute and Chairman of the Board, Mr C. E. T. Mann, was absent from duty on medical advice from 19 August to 21 September and from 5 to 18 November, during which periods the Deputy Director, Mr C. G. Akhurst, assumed the duties of Chairman of the Board. In July, Mr Mann announced his intention to retire, after having been in the service of the Board for over thirty-two years, and in December an advertisement was issued by the Minister for Commerce and Industry requesting applications for the post of Director.

The members of the Permanent Committee consisting of five Board members were:

- The Director, Mr C. E. T. Mann, Chairman
The Financial Member, Mr Lim Kim Cheng, M.C.S.
The Hon'ble Enche Abdul Jalil bin Haji Aminudin, P.J.K., J.P.
Mr J. C. Mathison, O.B.E., J.P.
The Hon'ble Mr Choo Kok Leong

During the year the Board held three statutory meetings, and one special meeting attended by Sir Geoffrey Clay, Controller of Rubber Research. The Permanent Committee met six times.

Ad hoc Committees of the Board met on several occasions; the one appointed to deal with houses and buildings met four times and the one concerned with the expansion of the Smallholders' Advisory Service held its first meeting.

The Board continued to receive the advice and assistance of the London Advisory Committee, whose Selection Sub-Committee and Agricultural Sub-Committee each met on two occasions.

Policy. No major change occurred in the Board's general programme of development for the Institute which follows the broad lines laid down in the Blackman Committee report; steady progress can be recorded under all headings of the Institute's activities.

The Controller of Rubber Research assumed duties in May and in October attended a Special Meeting of the Board at which he outlined his plans for re-organising the Malayan Rubber Fund Board's administration of the Institute and other bodies financed by the Malayan Rubber Fund. Sir Geoffrey Clay's proposals received the approval of the Board of the R.R.I.M. for transmission to the Minister for Commerce and Industry, Federation of Malaya.

Plans were approved to hold an International Natural Rubber Research Conference in Kuala Lumpur in September 1960. It is to be sponsored by the Institute and supported by the Rubber Industry and the Government of the Federation of Malaya. Preliminary notices announcing the event and giving it world wide publicity were issued in December.

Other important developments of the Board's policy were: (a) the progress of plans to investigate *Dothidella ulei* in Trinidad, resulting in the appointment of a microgeneticist, the Governing Body of the Imperial College of Tropical Agriculture having agreed to the establishment of a testing station at the College; (b) intensified measures to increase the effectiveness of the Smallholders' Advisory Service, principally by accelerated recruitment and training of staff; (c) the extensive building programme undertaken during the year (see under Programme of Research and Advisory Work); (d) the Board's decision to award Scholarships for students in the Faculty of Agriculture at the University of Malaya.

Finance. The Board's approved estimates of totals of expenditure and revenue are given below (the audited accounts are given at the end of this Report).

		<i>Approved Estimates</i>	<i>Actual Expenditure</i>
Headquarters and Laboratories		\$5,565,948	\$4,980,645
Experiment Station Sungei Buloh		\$1,660,777	\$ 913,604

Unfilled staff vacancies account for underspending of the approved estimates.

Total revenue on the Headquarters account was \$98,357; revenue from the Experiment Station accounts was \$1,248,392, giving a total revenue of \$1,346,749.

The total income of the Malayan Rubber Fund in 1959 was \$12,369,053.97, of which an allocation of \$4,113,128.00 was made to the R.R.I.M., representing 33.25% of the whole revenue. The Malayan Rubber Fund audited accounts are not gazetted as yet.

Staff. It is with regret that we have to record the death in July 1959 of the Secretary of the Institute, Mr H. S. Blacklin, who had been in the service of the Board for 27 years.

Report of the Board

During 1959, eight Division A Officers took up appointments, two being on secondment from the British Rubber Producers' Research Association. Two new Division B Officers were appointed.

At the end of the year there were vacancies on the establishment for seven Division A and six Division B officers.

Building. The main building developments during the year were the completion of a block of offices and laboratories facing Ampang Road in Kuala Lumpur and the erection of new laboratories for the Botanical Division at Sungei Buloh. The new block at Headquarters accommodates portions of the Botanical Division and of the Administration Section, as well as the Photographic Unit, and also provides a much needed Conference Hall.

A second glasshouse has been erected for the use of Soils and Botanical Divisions, and a new analytical laboratory for the Chemical Division, both at Headquarters. An improved and expanded ashing digestion room was added to the main laboratory of the Chemical Division, and an additional office was built for the Soils Division.

Programme of research and advisory work 1960. The Board approved programmes of work and estimates of expenditure for 1960 which were submitted to the Controller of Rubber Research in November.

C. G. AKHURST
Deputy Director

Report of the Director

The main conclusions reached in the course of the year's research are outlined below. A brief account of the work of the Statistics Section is also included in this report.

SOILS DIVISION

Manuring of Hevea

The general pattern of responses to fertiliser treatments, as determined by analysis of further data from the older field experiments, is similar to that reported in previous reports. It is firmly established that the main response has been to nitrogen and phosphate applications, both in young and mature rubber areas, particularly on inland soils. The same pattern, in terms of both growth and yield, has been recorded in several trials.

Potassium has had a variable effect depending largely on soil type and, in general, the responses were negative on heavier inland residual soils and coastal alluvial soils, but positive on sandy soils. A significantly positive nitrogen $\times$ potassium interaction was again recorded in trials on coastal clay soils.

In the single trial in which it was tested, magnesium limestone applied in the period 1951–1955 continued to have a marked positive effect on growth in 1959. Responses in terms of yield and growth were recorded in earlier years.

Cultivation and Ground Covers

Weed eradication. Experimental work carried out during the year included testing of several chemical weedkillers with the specific purpose of finding a suitable alternative to sodium arsenite for routine control of a mixed population of grasses and small herbaceous plants. The most effective of the herbicides tested are dalapon applied at the rate of 10 lb per acre, a mixture of dalapon and aminotriazole in equal proportions also at the rate of 10 lb per acre, and sodium chlorate. The latter at the rate of 25 lb per acre is less effective than sodium arsenite, but its effect is considerably improved by the addition of from 2 to 6 lb aminotriazole.

A new weedkiller K8606, not yet in large scale production, gave promising results when used to control an established growth of weeds, while Simazin and Atrazine showed promise as weedkillers which might be used for preventing or retarding growth of weeds after clearance of established growth.

Ground covers. Results of new experiments in progress show that trees grown in association with a ground cover of legume creepers girthed at a greater rate in the second year after planting than trees grown in association with grasses, *Mikania scandens* or mixed indigenous growths. The superiority of the legume creepers over the other types of ground cover was reflected also in the increased nitrogen and phosphorus content of the rubber leaves. Chemical analysis of green material and litter underneath the different ground covers confirms that legume creepers build up appreciably larger reserves of nitrogen than the other covers.

Soil Investigations

Following applications of ammonium sulphate, a marked depression in the pH value of soil and in the level of exchangeable cations has been recorded. The

depression in pH value was directly proportional to the amount of ammonium sulphate applied and was of the order of one pH unit after annual applications of 3 cwt per acre over a period of nine years.

Plant Investigations

Methods and techniques. A rapid method for estimation of nitrogen in plant tissue by direct nesslerisation of the kjeldahl digest has been successfully worked out and is being used for routine analysis in the laboratory.

Physiological diagnosis. A study of the practical applications of a technique of determining fertiliser requirements, based on the results of analysis of leaves and latex, and known as physiological diagnosis, was inaugurated during 1959 following a visit to Vietnam to discuss details of the technique developed by M. Beaufils of the Institut des Recherches sur le Caoutchouc au Vietnam.

A survey sampling of leaves and latex from RRIM 501, PB 86, Gl 1 and Tjir 1 in Selangor was started, with the object of studying the relationships between the performance of the tree and the mineral composition of the leaves and latex, and also of characterising the four clones in respect of mineral composition. Over a hundred samples have already been collected from approximately 4000 acres of mature rubber in Selangor. Fertiliser requirements based on physiological diagnosis are being studied in all areas included in the survey sampling, and the main requirements indicated so far have been for phosphate and nitrogen in that order, followed by magnesium and potassium. Manganese deficiency symptoms have been observed on many estates in Selangor.

Twelve pilot trials have been laid down to investigate both the validity of the method of physiological diagnosis, and also the effectiveness of fertiliser applications to mature rubber. In addition, four controlled experiments have been laid down to study the main effects of the fertiliser treatments indicated by physiological diagnosis.

Pot Culture Experiments

The results of a pot experiment designed to study the requirements of *Hevea* seedlings in the early stages of growth show that calcium is required before phosphorus, which in turn is required before potassium. The need for an external supply of calcium was indicated about 70 days after sowing whilst the corresponding periods for phosphorus and potassium were 115 and 148 days respectively.

BOTANICAL DIVISION

Research

The main items of the botanical programme are: breeding and selection; propagation and planting techniques; investigations of tapping methods including yield stimulation; physiological studies of the rubber tree; and ecological studies of cover plants.

Breeding and selection. The new hand-pollination programme of one large family (RRIM 501 $\times$ RRIM 623) and twenty exploratory crosses was inaugurated. One selfing programme with RRIM 501 was carried out. Counts were made of the success at the various stages of development of the large and the selfed families. Overall success at harvesting was 7.4%.

Further selections of clones derived from hand pollinations made since 1946 were made and budwood multiplied. Final selection of some ten to twelve clones will be made in 1960.

The number of pre-1942 variety trials was reduced to nine, and high tapping was started in two of these. Clones RRIM 501 and 513 gave very high yields from the high cut. Forty-two post-1946 trials were in tapping, and twenty-five were still immature.

In the mature trials it was found that clone RRIM 628 was the highest yielder, giving 145% of the yield of clone RRIM 501. Other promising clones were RRIM 605, 623, 600, 609, PB 5/51 and 5/63. On coastal clays clone RRIM 628, 501, 625, 623 and PB 86 were not liable to uprooting. Clones RRIM 626 and 621 and RRIM 501 were liable to trunk snap. A correlation of yield with the number of rings of latex vessels was found in clones RRIM 628, 621 and 625.

In a non-RRIM clones trial, LCB 1320, NAB 15 and Ch 26 were the most vigorous. RRIM 632 and 638 were relatively vigorous in a trial of the later RRIM 600 series. A report on the exchange clones trial was issued during the year.

Observations on wintering, secondary leaf fall and incidence of *Gloeosporium* were also made. An investigation into recording techniques was carried out.

Propagation and planting technique. Roots were obtained from both large and small marcots and from layered budwood stems. Ensuring the survival of the marcots after removal from the mother plant proved difficult; an experiment with large marcots was a failure.

Rooting of hardwood cuttings also proved unsuccessful, but there was some success with leafy cuttings, after improvements had been made in the environment. Cuttings from clones PB 86 and GT 1 rooted quite readily, when a fungicide was used as a dip. Production of such cuttings is now on a sufficient scale to provide material for experimental work.

One hundred and fifty clones were tested for rooting ability; the level of success in rooting was over 60% (on one or more occasions) for fifty of the clones, over 60% for seven out of eight *H. brasiliensis* $\times$ *H. benthamiana*, 83% (average) for PB 86 in thirty-three experiments and 81% (average) for GT 1 in thirty experiments.

A crown budding experiment continues to show a marked influence of crown on girth increment of the trunk. A stock/scion experiment in which cuttings and budded stumps are used has also been established.

Tests were made with the storage of *Hevea* seeds in polythene bags; after seven weeks of storage, 62% germination (initial germination 74%) was obtained. When seeds were stored in similar bags at 40°F and at room temperature, germination after twelve weeks was 68% and 62% respectively (initial germination 89%).

Tapping. After consolidation of records from a number of trials the results were published in the form of practical advice in *Planters' Bulletin*; the article described treatments devised to give maximum exploitation of clones and clonal seedlings. Recommendations were given for normal treatment of young material, and for the application of yield stimulation and intensive tapping at suitable periods in the life of the tree.

Report of the Director

Physiology and morphology. A large number of screening trials and larger trials of new substances during the year indicated that, in spite of disadvantages, both 2,4-D and 2,4,5-T were still the most useful plant growth substances for yield stimulation. Bactericides, both alone and in combination, were also tested.

Chromatographic work and bio-assay showed 2,4,5-T to be present in a neutral form in the aqueous fractions of latex from plants stimulated with the normal butyl ester. In other plants it is reported that the esters are hydrolysed. It is not known at the moment if the neutral form is an ester.

Yield increases with copper sulphate could not be correlated with increase of growth substance activity in the latex, thus suggesting a mode of action different from that of plant growth substances.

Growth studies on the effect of tapping were inconclusive in the early stages, except where clone PR 107 was opened at a girth four inches below standard. Small differences in girth increment have also been shown. A correlation coefficient of + 0.60 has been demonstrated between yield per tapping over six months and girths at the beginning (or end) of this period.

Comparisons of the growth of buddings of clone RRIM 501 and 513 from the time of budding showed greater node height in the former. Node height appeared to be governed by stock size; with increasing size of stock, clonal differences decreased. *Hevea* grows in height discontinuously, with delays at the nodes, but the faster growing RRIM 501 showed more rapid elongation of internodes than RRIM 513. Girthing on the other hand appeared to be continuous.

Experiments to compare the effects of pruning treatment and pollarding were commenced. Recommendations regarding wind break in clone RRIM 501 were published in the *Planters' Bulletin*. Timber tests disclosed that the mechanical strength of the wood of clone RRIM 501 varied little from clone PR 107 and that NPK manuring at different levels made little difference. Anatomical studies of wood were commenced.

Ecology. The procedure in sampling natural vegetation was varied to obtain information on percentage coverage of species, unit plant size of species, and density.

A plant museum of the R.R.I.M. collection of cover plants was started at the R.R.I. Experiment Station. Three hundred and ten accessions to the herbarium were made.

Advisory. The volume of correspondence to the Division showed no increase over the previous year. This was due to the amount of routine Advisory work undertaken by the Estates Advisory Service with whom there was excellent co-operation.

PATHOLOGICAL DIVISION

Research

Root disease. Much of the effort of the Division, which is concentrating its resources on root disease investigations, has been put into maintaining and further extending the field experiments bearing on root disease control. Whilst most of the experiments will take some years to reach fruition, results have been obtained showing that root disease in a replanting can be reduced by treating the surfaces of stumps of the old stand with a wood preservative.

Artificial inoculation studies have been pursued, using lengths of naturally infected root as inocula. It has been found that both species of *Fomes* (*F. lignosus* and *F. noxius*) have made more rapid growth inwards towards the bole of the tree than outwards from the site of inoculation on a lateral root.

The power of recovery of infected trees has been shown by the eventual failure of infection to become established in a high proportion of 122 four-year-old trees inoculated with *F. lignosus* in connection with tests of collar fungicides. Similarly, the inoculated roots of 25 eight-year-old trees were all alive two years later.

No effect of root disease on yield has yet appeared in the experiment, laid down in 1958, where mature trees have been infected with the three major root diseases. Growth rate analysis has shown that the *F. lignosus* isolates so far collected fall into three broad groups, which bear some relationship to the sources of the cultures.

A method has been developed to induce sporophore production by *F. lignosus* cultures, by allowing them to colonise a wood block which is then surrounded by soil.

Automatic volumetric spore trapping has shown the large numbers of *Ganoderma* spores in the air, but has proved ineffective for the study of *F. lignosus* and *F. noxius*, the spores of which are not distinctive. Attempts to inoculate freshly cut stump surfaces with fresh spores of *F. lignosus* have been unsuccessful, despite a moist surface and the size of the wood elements—large enough to allow a spore to enter.

Observations have been continued on the rate of defoliation of poisoned trees, and on the death and decay of poisoned trees and stumps. Though sodium arsenite gives a quicker result as a tree poison, 2,4,5-T leads to more rapid decay.

Panel diseases. No research has been done on mouldy rot but two proprietary materials have been tested for gazing as additions to the list of approved fungicides.

Leaf diseases. Power-operated knapsack mist blowers have proved fully satisfactory as a means of applying fungicides for the control of bird's eye spot (*Helminthosporium heveae*), quickly covering the ground and giving a uniform deposition on both sides of even the youngest leaves. Oil-based mercurised copper oxychloride scorched the leaves; ferbam and ziram formulations showed promise.

Pests. Control of grubs of the cockchafer *Holotrichia bidentata* attacking young rubber was attained most rapidly with heptachlor, more slowly with aldrin and most slowly with chlordane. Four pints of 0.1% insecticide were poured into dibble holes around each tree.

Damage done to young *Hevea* by a number of small mammals has been characterised, including that done by squirrels and a new pest—the bamboo rat (*Rhizomys sumatrensis*).

Advisory Work

Interest in chemical prevention and control of root disease has been stimulated by the introduction of a proprietary material claimed to be of value for these purposes. Our view is that the chemicals at present available are not to be relied on for prophylactic treatment, though they may be found to have some use in the treatment of diseased trees. From our experience, however, it would appear that

the most important part of root disease treatment consists in severing the connection with the source of infection.

The demand for *Rhizobium* cultures for the inoculation of cover crop seed continues to increase. During the year, more than 13,000 packets of *Rhizobium* compost culture were despatched on demand to estates and smallholdings.

The book *Maladies of Hevea*, describing the diseases of rubber in Malaya, was published early in the year and over 1,000 copies have been sold. Work on the companion volume that will deal with pests of rubber and cover plants has been actively continued.

CHEMICAL DIVISION

Fundamental Research

Biochemistry. Work on the separation of latex proteins has continued, employing modern techniques such as starch gel electrophoresis and ion exchange materials. Up to 22 protein components occur in sera from fresh latices and 10 components, some probably different from those identified in the sera, are present in the jelly-like bottom fraction separated from latex by high speed centrifuging. The work of analysing and identifying the major components is at an early stage; interesting comparisons have been made with work carried out in the British Rubber Producers' Research Association laboratories.

The study of latex fractionation by high speed centrifuging is being continued.

Microbiology. Recent work has attempted to improve techniques for counting and identifying bacteria in latex, both aerobic and anaerobic. It has been found that considerable numbers of the latter can occur in shipments of latex concentrate reaching Great Britain. Current work is directed mainly towards finding out how bacteria affect the non-rubber constituents of latex and how they modify its technical behaviour. Preliminary observations indicate a close relation between bacterial activity and volatile fatty acid formation.

Large scale trials to study the value of applying antibacterial treatments to trees in tapping have been taken over by the Botanical Division. Further small scale experiments by the Chemical Division have shown that within three months of opening a new tapping cut, the latex-bearing tissues are so contaminated with bacteria that a count of one thousand viable bacteria per millilitre is found in the emerging latex.

Colloid chemistry. Using recently developed optical microscope equipment it was demonstrated that fresh latex contains complex particles showing an internal structure in which active movement occurs. Shortly after latex leaves the tree, the active movement ceases and disintegration of the particles appears to commence.

A microscope study of the different fractions which can be separated from fresh latex by high speed centrifugation is now in hand.

Polymer chemistry. Previous studies have established the occurrence in fresh rubber of active centres, which readily undergo chemical changes and lead to modification in properties of rubber during shipment and storage. A study of the reactions which these centres undergo has led to the conclusion that they may be carbonyl groups. Working on this hypothesis, it has been shown that the changes in hardness which occur after the rubber leaves the tree can be enhanced or

reduced. Small quantities of treated rubber shipped to Great Britain showed no changes in viscosity on arrival.

New and cheaper methods have been discovered for producing rubbers having superior processing characteristics (SP rubber).

Drying of coagulum. Examination of the factors controlling the rate of drying of rubber coagulum has led to a clearer picture of the requirements for efficient operation of drying houses. The basic information obtained has been summarised in the form of a nomograph, which it is hoped will be of value in the design and operation of commercial driers. The data provided set out the effect of temperature, humidity and sheet thickness upon the time required to dry coagulum from 15 to 0.7 per cent water—which represents the major part of the drying time.

Applied Research

Latex technology. The effect of manurial treatment upon the properties of latex concentrate has been studied in co-operation with Soils Division. At present, data are available from only one of the two estate trials in hand; they indicate that increases in the nitrogen content of latex follow the application of nitrogen, and increases in potassium follow potassium or nitrogen treatments. The effect upon technological properties of the latex was small.

A considerable effort has been made to develop new systems of preservation with low ammonia content which will confer optimum properties on latex concentrates. Since the use of three different preservatives at a time is now common practice, the combinations of possible reagents are extremely large and the volume of work required to assess them makes evaluation difficult and time-consuming. A number of promising new systems are being examined and a number of reagents have been examined and rejected as unsuitable.

Examination of latices from new clones for concentrate production has been continued.

The suitability of latex concentrates for foam manufacture has been studied in practical foaming trials. This work has demonstrated that differences between the different types of commercially available low ammonia latex are small, but may require adjustment of compounding formulations in some cases.

It has been observed that the loss in compression modulus of natural rubber foams on repeated flexing is not necessarily permanent and may be restored by appropriate treatment.

Rubber technology. A thorough revision of laboratory test procedures has been undertaken and cross-checks made with other laboratories. Experimental work includes a study of lower grade rubbers, which is being carried out in collaboration with the B.R.P.R.A.

Work on superior processing rubbers has taken up much of the time available, and a new test has been developed to permit more rapid checking of commercial samples. Quality control charts have now been set up for each estate producing SP rubber.

Samples of red clay masterbatch have been received from Indo-China and examined for technical behaviour. The material does not appear to offer marked advantages over existing ones.

Further observations on the relation between vulcanising characteristics and chemical analysis have confirmed earlier findings.

Process Evaluation and Factory Studies

Effluent disposal. Trials with the trickling filter set up at the Sungei Buloh Factory show that substantial reduction in the B.O.D. (biological oxygen demand) of factory waste can be obtained by this means. The presence of ammonium sulphate in effluent from latex concentration makes disposal more troublesome, but satisfactory results can be obtained, particularly if recycling of the effluent is employed.

Recovery of ammonia and rubber from latex skim. The first step in this project has been to examine the economic aspect. A design study shows that steam stripping of the ammonia direct from latex skim, and separate concentration of the dilute ammonia solution obtained, would probably lead to a reduction in costs for estates which use 0.5% ammonia, in field latex for centrifuging. For estates using 0.3% ammonia, a direct saving in costs is less probable, but the use of this method would lead to improved efficiency in skim-rubber production.

Practical trials in the laboratory have demonstrated the feasibility of the process and shown that latex skim coagulates very easily after ammonia removal.

Use of skim as fertiliser. A convenient way of disposing of factory waste would be to use it as a fertiliser, since it contains a considerable quantity of nitrogen. To avoid handling large bulks of fluid, methods of concentrating it to smaller bulk were studied. These proved to be uneconomic and recommendations to utilise the effluent locally by distributing it in nearby plantations have been made.

MG rubber. A commercial-scale process for manufacturing methyl methacrylate graft rubbers (MG rubbers), starting with field latex, has been finalised and has been used for small scale production. The demand for the material is small, however, and commercial development does not appear very promising.

Design of drying houses. Observations made during the course of laboratory work to study the drying of rubber coagulum are now being applied to the design of more efficient driers. It is apparent that the use of thin sheet and two-stage drying offer advantages, notably a greater throughput and a reduced tendency to bubble and blister formation.

Bubbles in sheet. A preliminary survey of a number of bactericides, antibiotics, etc. has been carried out to examine their effect in decreasing the number of bacteria present in field latex, so reducing bubble formation in sheet rubber. So far, no preservative more effective than formaldehyde has been discovered.

Superior processing rubbers. Practical developments in SP rubbers have centred around the production of a satisfactory masterbatch or concentrate, PA 80, which can be mixed in small amounts with any grade or type of rubber, natural or synthetic, to confer better processing characteristics.

Many problems were encountered in commercial scale production, particularly creping and drying. A satisfactory process has now been worked out in which the PA 80 is produced as a crumb and is compressed into blocks for easy transport. The process is now being used for commercial production.

The total quantity of SP rubbers of all types produced at the Experiment Station Factory during the year was just over 57 tons.

Advisory and Technical Services

The volume of advisory work has increased during the year, records showing 10 to 15 per cent more correspondence and visits than last year.

Increased crops have led to enquiries on plans for enlarging factories and smoke-houses and on more efficient use of existing facilities. Greater variability in the crop has been observed and recommended modifications in processing to maintain more uniformity in the technical properties of sheet rubber have proved successful in most cases. Bubbles in sheet have been prevented by the use of suitable anti-coagulants, coagulation at a lower d.r.c. and machining to a thin sheet. Many estates have adopted oil-heated, air-circulating drying tunnels with satisfactory results.

Few problems in producing pale crepe with a good colour were encountered, but complaints were received about discolouration on storage. In a number of cases the addition of a small proportion of oxalic acid to the coagulant proved beneficial.

Many enquiries were received concerning latex concentrate production including those with low ammonia. Production of boric acid concentrate has doubled during the past year. The standard of cleanliness maintained in Malayan latex factories was high, and few complaints have been received from consumers.

A number of special rubbers based upon RRIM processes are now being produced in Malaya in commercial quantities. These include cyclised rubber, partially purified crepe, and the SP series of rubbers. Of these the SP rubbers represent the greatest tonnage, 2316 tons having been produced during the year by eight commercial estates and the R.R.I. Experiment Station.

The number of estates participating in the scheme for Technical Classification has fallen from 92 to 70, but the output of TC rubber has remained at about the same level, being 28,473 tons for 1959 as compared with 28,785 tons for 1958. Most of the estates withdrawing from the scheme have stopped smoked sheet production and are now selling latex or other products. Little rubber was submitted from packing houses for classification, the total from five different concerns amounting to just over 400 tons.

Towards the close of the year, the need for a technical service to local rubber manufacturers was officially recognised. During the year 46 enquiries were received and were dealt with by the staff of the technological laboratories.

SMALLHOLDERS' ADVISORY SERVICE

Planting of rubber. New planting of rubber recorded by Rubber Instructors totalled 13,681 acres, of which 8,034 acres were planted with clonal seedlings. The acreage of new planting is little higher than in the previous two years and the usage of clonal seedlings is greater than in 1958. Budgrafting was reported on 5,405 acres, which indicates that previous plantings of unselected seedlings have all been budgrafted.

In addition to new planting undertaken by individual smallholders, a large acreage of new planting in organised Land Development Schemes has been undertaken. A total of 25 schemes in Kedah, Malacca, Negri Sembilan and Trengganu have planted 7,194 acres and within the same schemes 2,600 acres have been

budgrafted. A number of other Land Development Schemes were in various stages of planning; advice on these and on established schemes occupied the time of one Senior Officer.

Advisory work in connection with replantings continued to occupy a high proportion of the time of field staff, particular effort being devoted to those holdings which had received the final grant payment under the Replanting Scheme. Contact was made with all such holdings as a preliminary to intensive advice on opening for tapping and on processing the latex. Co-operation with field staff of the Rubber Industry (Replanting) Board was close, and an agreed procedure for collaboration between the two organisations was put into effect.

Manufacture. Sales of latex by smallholders continued at a steady rate; 5,524 tons (expressed as dry rubber) were sold for processing into sheet or concentrated latex.

Considerable effort was devoted to popularising Group Processing Centres where smallholders process their latex individually but use communal equipment. At the end of the year, thirty-five Group Processing Centres were in operation and were catering for 613 smallholders producing approximately 950 piculs of dry rubber per month. Of the thirty-five centres, sixteen had their own smokehouses but all produced smoked sheet; those without smokehouses made use of previously existing facilities.

Most smallholders using Group Processing Centres sell their rubber individually after smoking, but at three centres bulk sales of rubber were introduced during the year.

In connection with the encouragement of Group Processing Centres, a separate demonstration unit carrying the equipment necessary for good sheet making was in use from August onwards. This Unit gave thirty-two demonstrations and film shows to groups of smallholders; in addition 155 demonstrations utilising equipment available on smallholdings were given by Assistant Rubber Instructors.

Training courses. Provision of training courses for groups of smallholders continued and 372 students completed courses during the year. Special courses for staff of other organisations were arranged at the R.R.I. Experiment Station and at the Smallholders' Rubber School, Ayer Pa'abas.

Information. The mobile film unit provided 138 kampong film shows during the year. In addition films were shown at agricultural shows and in conjunction with all training courses. Revised editions of advisory literature and a series of posters on sheet preparation were published during the year.

ESTATES ADVISORY SERVICE

The development of the Estates Advisory Service has been restricted by the difficulty of obtaining suitably experienced staff for the work. The service continued to handle all routine enquiries in the field of work of the Soils Division and consequently a high proportion of letters written in response to enquiries dealt with manuring and cover plant problems. Advice given following visits to estates was spread more evenly over the agronomic field.

It has been the primary aim of the new service to extend the work and influence of the Institute among the smaller estates of between 100 and 1000 acres. Two out of every three estate visits were to Malayan-owned properties, although

these comprise only 37% of the total acreage of rubber estates. The Malayan-owned estates are however three times more numerous than the larger European-owned estates and the proportion of visits to them should increase with growth of staff. Enquiries from the smaller estates show that, whereas the value of technical information is appreciated on such subjects as diseases, pests, planting material, fertiliser use and suitability of soil for rubber, the possibilities of assistance in other fields are not always realised. Examples are the relative absence of any systematic use of intensive tapping and yield stimulation for the long-term exploitation of rubber trees prior to replanting and failure to thin out adequately before and after opening for tapping. Such practices and many others must be correctly demonstrated and their importance brought to the attention of small estate owners and managers.

A survey of Chinese-owned estates of 1000 acres or less, undertaken with the twin objects of obtaining and disseminating information, has shown that there is a need for verbal advice and printed material to be provided in the Chinese language on well over 50% of estates. This requirement is probably closely related to the other notable fact revealed by the survey that on about 50% of estates there is no immature rubber and on an even higher proportion there is no high yielding mature rubber. There is thus considerable scope for improvement in productivity.

Future plans for the continued development of the Estates Advisory Service include provisions for a total of six senior officers. This increase in staff will permit continuation of routine advisory work formerly done by the Soils, Botanical and Pathological Divisions for the large company-owned estates and expansion of the work of the Institute for the smaller, proprietary estates. This latter service will be supported by work of the publications service in producing Chinese and Malay editions of our *Planters' Bulletin*. Full requirements for expansion cannot be accurately forecast at this stage but it is clear from a study of available statistics and from our field experience that successful operation of the service as at present planned will create the need for further expansion.

STATISTICS SECTION

The post of Head of the Statistics Section, which had remained vacant since March 1957, was filled in November 1959 by the return of Mr D. R. Westgarth. The Acting Head of the Section, Mr A. Fong Chu Chai, was on duty throughout the year, but the remainder of the Staff was heavily depleted by training courses and long leave.

The Section continued to be engaged mainly in processing and analysing data from the field and laboratory experiments of the Research Divisions. The volume of this work increased considerably during the year, and altogether about 180 statistical analyses were provided. Statistical advice was also given on the planning of eleven new experiments.

The use of the punched-card installation for summarising field records, preparatory to statistical analysis, was extended, and about 90 summaries were prepared.

C. G. AKHURST
Deputy Director

Soils Division

Division A officers on duty at the commencement of the year were Mr G. Owen (Head of Division), Mr K. R. Middleton, Dr V. M. Shorrocks and Mr J. Bolton. Dr G. A. Watson, who was absent on home leave at the beginning of the year, returned in July. Dr V. M. Shorrocks went on home leave in August. Mr G. Owen was appointed Acting Deputy Director with effect from 3 December when the Deputy Director went on home leave and during this period Dr G. A. Watson acted as Head of Division.

One Division B officer, Mr K. Raman, was on duty throughout the year.

The Head of Division and Dr Shorrocks visited Vietnam for six days in May to discuss with M. Beaufils of the Institut des Recherches sur le Caoutchouc au Vietnam, the basic principles and operational details of the technique he has developed for a diagnosis of the fertiliser requirements of *Hevea brasiliensis*, based on the results of chemical analysis of leaves and latex. The opportunity was taken to visit a number of large rubber plantations in Vietnam to obtain information on, and to see, the results obtained in the first year following the application of M. Beaufils' technique for large scale manuring of rubber.

The following short articles prepared by members of the Soils Division staff were published in *Planters' Bulletin*:

Rock Phosphate versus Superphosphate ...	...	...	<i>Planters' Bulletin</i>	41
Manganese Deficiency ...	...	...	"	42
Control of Weeds on Malayan Rubber Estates ...	...	...	"	44

RESEARCH

MANURING OF HEVEA

There has been a major change in the field experimental manuring programme during 1959. All except three of the older fertiliser trials started in the period 1934 to 1941, which have provided the bulk of the field experimental data on manuring since the war, have been terminated. The termination of these trials is mainly responsible for the decline in the total number of field experiments in progress at the end of the year. In the majority of these older trials, fertiliser treatments were applied bi-annually over a period of six years immediately following rehabilitation after the war (1948-1955) and the pattern of fertiliser responses which has developed in the different areas is now well defined. Work is proceeding on summarising and analysing the mass of data obtained in the pre-war and post-war periods, part of which has already been published in the *Journal of the Rubber Research Institute of Malaya*. (AKHURST AND OWEN, 1950; OWEN, WESTGARTH AND IYER 1957).

The numbers of field experiments at the beginning and end of 1959 are as follows:

		Jan. 1959	Dec. 1959
Manuring experiments, mature rubber:	(a) on estates	24	11
	(b) on the Experiment Station	6	9
Manuring experiments, immature rubber:	(a) on estates	5	9
	(b) on the Experiment Station	5	5
Experiments involving cover crop and fertiliser treatment:	(a) on estates	8	7
	(b) on the Experiment Station	2	3
		50	44

In addition to these full scale experiments, twelve small scale trials are in progress, designed to investigate various aspects of the manuring of ground covers and young rubber.

Of the new series of trials started during the period under review, one series of four trials sited on coastal alluvial clay soils is designed to investigate further the nitrogen-potassium interaction reported previously in the *Journal of the Rubber Research Institute of Malaya*, Volume 15 (OWEN, WESTGARTH AND IYER 1957) and they incorporate treatments with phosphorus, potassium and magnesium as well as with two different sources of nitrogen.

Another series includes three trials in areas of young rubber in tapping, involving fertiliser treatments based on a diagnosis of the nutrient requirements of the trees in each area by a method developed by Beauflis of the I.R.C.V. using the results of leaf and latex analysis. They incorporate comparisons of rock phosphate and ammonium phosphate as well as tests of the effect of manganese sulphate and copper sulphate and the normal N,P,K, Mg fertilisers. Further experiments of this type are planned to commence in 1960.

New experiments at the Experiment Station started during the year include one to determine the effects of different levels of application of nitrogen and potassium in the presence and absence of magnesium, and another designed to compare different nitrogen and phosphate fertilisers in the presence and absence of lime. Both these experiments are sited in a newly planted area cleared from jungle. Other experiments are designed to determine the effect of manuring with various types of phosphate fertilisers at different rates of application on the growth of young trees and mixed leguminous cover plants.

Some of the older experiments have been modified by changing the treatments, splitting the plots or by the use of additional confounding in factorial arrangements. A cultivation treatment in one trial has been replaced by applications of magnesium limestone, since the trees in this area showed marked symptoms of magnesium deficiency. Treatments with magnesium limestone and manganese sulphate have been incorporated into an existing manurial trial where the results of leaf analysis indicated a deficiency of these two nutrient elements.

Owing to the large volume of data collected, it is impossible to review in a few paragraphs the results obtained from all the trials. In the following account, general trends are discussed and only a few of the more interesting results from individual trials are mentioned.

Effect of Fertilisers on Growth

The general pattern of fertiliser response is similar to that reported in previous years. In the mature areas, the main response in girth increment has been to nitrogen and phosphate applications, particularly on the inland soils group. Potassium has had a variable effect on the different soil types; in general, the statistically significant responses are negative on inland clay loams and coastal alluvial clay soils, but positive on sandy alluvial soils such as those found on parts of the Experiment Station (Sungei Buloh Series). In the single trial in which it was tested, magnesium limestone applied in the period 1951–1955 continued to have a marked positive effect on growth in 1959. In an area of mature rubber showing clear symptoms of manganese deficiency, no response to three annual applications of manganese sulphate was detected, although there has been a distinct improvement in the foliage in the manganese treated plots.

In the immature areas, the main response has again been to nitrogen and phosphate fertilisers, and to the former in particular on the lighter soils. This marked response to nitrogen was emphasised in one NPK factorial trial where the 'no nitrogen' plots were so backward that a basic nitrogen dressing was applied on all plots. The basic dressing had a much greater effect on girth increment in the 'no nitrogen' than in the 'nitrogen' plots and brought out significant positive phosphate and potassium responses which had not previously been detected in this particular area where experimental fertiliser treatments have been applied regularly since 1947.

Data from two trials on coastal alluvial clay soils show a significant positive nitrogen-potassium interaction similar to that previously reported in the *Journal* for mature rubber areas (OWEN, WESTGARTH AND IYER 1957). These are difficult to explain without further data which should be forthcoming from some of the new trials.

Effect of Fertilisers on Yield

Annual yield records from twenty-six manuring experiments have been analysed and these also show responses similar to those reported previously. A positive phosphate response is recorded in eight trials, a nitrogen response in four trials and a positive response to potassium in one trial. In three trials, the effect of potassium applications is significantly negative.

Of particular interest is a response to phosphate fertilisers on a coastal alluvial clay soil. This response has built up over ten years to an increase of about 5% of the mean yield. Over the whole ten years of tapping, however, the total response was small, not statistically proven and probably not economic when measured against the cost of treatment.

In another trial on an inland clay loam, recent data collected show a statistically significant increase in yield for the first time in ten years, following biennial applications of nitrogen and phosphate over the whole period. Inspection of the results

however, shows that the same responses to treatment were obtained earlier but that the recording was not sufficiently precise to detect them with confidence. The results from this trial, and from several others which have been analysed, emphasise the long-term nature of the manuring of rubber trees.

Effect of Fertilisers on Seed Production

The seed fall from each plot of three fertiliser experiments was measured during the year. In one experiment, the autumn seed production, as measured by both weight and number of seed, was increased by phosphate and reduced by potassium treatments applied annually since 1957. Results from the other two trials, one manured annually since 1957, and the other manured for the first time in 1959, showed no definite response to treatment with nitrogen, phosphorus or potassium.

CULTIVATION AND GROUND COVERS

Weed Eradication

Further small scale trials have been carried out with sodium chlorate, Atlavar (a weedkiller formulation containing sodium chlorate and CMU as active ingredients), sodium trichloroacetate, Telvar W, Simazin and Atrazine. New weedkillers tested include FB 2, K 8606 and Methoxypropazine.

In current work, the main objective has been to find a suitable alternative to sodium arsenite, mainly for control of weeds along planting rows. Grasses are the most persistent weeds and the most difficult to control. The two grass species most commonly found, and the ones that tend to assume dominance in the majority of rubber areas, are *Axonopus compressus* and *Paspalum conjugatum*. Most of the trials were therefore carried out in areas where one or other of these two grasses was the dominant weed. Trials have also been carried out on a more mixed population of weeds in planting rows.

Axonopus compressus. Treatment with dalapon at the rate of 10 lb per acre was included in the majority of trials as a standard for comparison. Results obtained with dalapon were variable, but effective control of grasses was recorded in nine out of thirteen trials. New growth of grass usually began to appear at about ten to twelve weeks after spraying in open ground, but the effect persisted longer under shade. Effective control of the majority of the smaller grasses along planting rows (in rubber areas about three years old or more) can be achieved by spraying with dalapon at the rate of 10 lb per acre, followed by 5 lb per acre at intervals of about five or six months. This applies only if *Paspalum conjugatum*, which is resistant to dalapon, is absent.

Sodium chlorate applied at the rates of 20 and 25 lb per acre gave variable results, but usually killed aerial growth almost immediately. Regeneration of growth became evident two to five weeks after spraying. Sodium chlorate was appreciably less effective than dalapon. The effect of sodium chlorate was considerably improved by the addition of aminotriazole. Good results were obtained with a solution containing the equivalent of 20 lb sodium chlorate and 2 lb aminotriazole in 100 gallons of water.

Atlavar was ineffective when applied at rates of 10, 15 and 20 lb per acre. Application at the rate of 25 lb per acre gave 50% control measured four weeks after spraying, but the grass recovered rapidly after six weeks.

Telvar W, applied at the rates of 2, 3 and 4 lb per acre, was ineffective. Good results were obtained with mixtures of Telvar W (3 lb) with other weedkillers such as sodium chlorate (20 lb), TCA (20 lb), Simazin (10 lb), Atrazine (10 lb) or aminotriazole (8 lb). Weights given are in pounds per hundred gallons of water per acre. Results with mixtures of Telvar W with other weedkillers are sufficiently encouraging to warrant further tests.

Simazin and Atrazine proved to be relatively ineffective for control of established growth of grasses and other weeds. Atrazine was generally more effective than Simazin. The rates of application tested were 5, 10, 15 and 20 lb per acre. In one trial an application of Atrazine at the highest rate (20 lb per acre) was about as effective as dalapon at 10 lb per acre, giving useful control of grasses for about three months. Simazin and Atrazine, however, are more likely to be useful as pre-germination weedkillers to be applied after the established growth has been eliminated or suppressed by other means. Applied at 5 or 10 lb per acre, both proved to be more or less effective in retarding growth recovery of grasses and other weeds, particularly following treatment with the less persistent weedkillers such as sodium chlorate or sodium arsenite. The effect, though small and probably uneconomic, was readily detectable and it was noted that Atrazine was generally more effective as a pre-germination weedkiller under local conditions than Simazin. When the more persistent weedkillers such as dalapon or aminotriazole were used, subsequent applications of Simazin and Atrazine as pre-germination weedkillers produced no important effects. Recovery of growth of grasses after spraying with dalapon was not delayed to any appreciable extent by spraying with Simazin or Atrazine ten to thirty days later. Both are more effective against broad leaved species of weeds than against grasses. It was noted that *Digitaria longifolia* and *Tricholeana rosea* were the first grasses to colonise the areas treated with Simazin and Atrazine, although they were not dominant initially.

Methoxypropazine, another member of the group of triazine derivatives was ineffective in killing established growth of *Axonopus compressus* and other grasses when applied at the rates of 2½, 5 and 10 lb per acre. One application at the rate of 15 lb per acre gave about 50% control, but growth regeneration was rapid after four weeks.

Diquat or FB 2 (1:1 ethylene-2:2-dipyriditium dibromide), a newly introduced herbicide, was tested on a limited scale during the year. Applications at the rates of 1, 2, 3 and 4 lb per acre resulted in almost complete browning of grasses and broad leaved herbaceous growths within the first day or two, but recovery was rapid after about two weeks.

More promising results were obtained with another new weedkiller K 8606. Only a small sample quantity of this new chemical compound was made available, sufficient only for a few exploratory small scale trials. In one trial good results were obtained with applications at the rates of 1, 2, 3 and 4 lb per acre. The percentage kill of mixed grasses (*Axonopus compressus* dominant) was estimated to be over 90% in each case, but the rate of recovery after treatment depended on the level of application. New growth began to appear at 4, 5, 6 and 10 weeks after treatments at the rates of 1, 2, 3 and 4 lb per acre respectively. In this preliminary trial, K 8606 applied at the rate of 4 lb per acre compared favourably with sodium arsenite (15 lb) in intensity and rapidity of effect, and with dalapon (10 lb) in persistence. In a second trial, application at the rate of 2 lb per acre

was less successful than in the first trial, but 4 lb per acre again gave a high degree of control (80% kill). The preliminary results suggest that this new weedkiller may be a particularly suitable alternative to sodium arsenite for the routine control of weeds in planting rows and further trials will be carried out when supplies are available.

Several mixed formulations of herbicides were tested and good results were obtained with mixtures of sodium chlorate (15 lb) with either dalapon (5 lb) or aminotriazole (5 lb). Both mixtures were more effective than sodium chlorate (20 lb) alone and compared favourably with dalapon (10 lb); there was little or no new growth until about ten to twelve weeks after spraying. A mixture of sodium chlorate (15 lb) with Atrazine (5 lb) was rather less effective but gave better results than sodium chlorate (20 lb) alone. The addition of Simazin (5 lb) did not enhance the effect of sodium chlorate.

Mixtures of dalapon (5 lb) with either aminotriazole (5 lb), Simazin (5 lb) or Atrazine (5 lb) gave useful control of *Axonopus compressus*, the effect persisting for eight to twelve weeks, and compared favourably with dalapon at 10 lb per acre.

Good results were obtained also with mixtures of Telvar W (3 lb) with dalapon (8 lb), sodium trichloroacetate (20 lb), Simazin (10 lb), Atrazine (10 lb) and aminotriazole (8 lb). In each case the mixture was more effective than either of the two components applied singly at higher rates. Best results were obtained with the Telvar W/Atrazine and the Telvar W/aminotriazole mixtures when little or no new growth occurred up to four months after spraying.

A mixture of K 8606 (2 lb) with either Simazin (10 lb) or Atrazine (10 lb) was also effective. Estimated growth recovery was less than 30% at three months and about 50% at four months after spraying.

Paspalum conjugatum. The most effective of the weedkillers tested for control of this grass was aminotriazole. Consistently good results were obtained with applications at the rate of 10 lb per acre. The effect develops slowly and increases steadily up to about three months after spraying.

Dalapon (10 lb), Telvar W (2, 3 and 4 lb), Simazin (5, 10, 15 and 20 lb) and Atrazine (10 and 15 lb) were ineffective. K 8606 was less effective on *P. conjugatum* than on *A. compressus*, the effect, estimated to be about 50% control, lasting for only about four weeks. Diquat (FB 2), on the other hand, was more effective on *P. conjugatum* than on *A. compressus*, but again, recovery was rapid after about four weeks.

The various mixtures tested were generally less effective on *Paspalum* than on *Axonopus* although most of them gave better results than either of the two components applied singly. Best results were obtained with a mixture of Telvar W (3 lb) and aminotriazole (8 lb). One application of this mixture gave useful control for four months; at the end of this period recovery was estimated to be only about 20%.

Mixed weeds in planting rows. Strip spraying trials were carried out in different areas and results varied considerably depending on the composition of the weed species and the amount of shade provided by the rubber trees.

One trial was carried out in an area where the rubber trees were three years old, thus providing partial shade. Vegetation in the planting rows consisted of

mixed grasses and a variety of broad leafed species including legume creepers and *Mikania scandens*. *Paspalum conjugatum* was the dominant grass species. Best results in this trial were obtained with a mixture containing 5 lb dalapon and 5 lb aminotriazole in 100 gallons of water. The effect developed more slowly but persisted much longer than that of either sodium arsenite or sodium chlorate. Satisfactory control of all weeds in planting rows was achieved by spraying with the mixture at six-monthly intervals, compared with the three-monthly sprayings necessary with sodium arsenite. The new weedkiller K 8606 (3 lb per acre) also gave useful control of all weeds, the immediate effect being similar to that obtained with sodium arsenite (over 95% control) but more persistent. A mixture of sodium chlorate (20 lb) and aminotriazole (2 lb) gave better results than sodium chlorate alone. CMU (3 lb per acre) was ineffective.

In a replanted area where spraying treatments were carried out in the period from immediately before planting up to six months after planting, and where *Axonopus compressus* was the dominant grass species, the best results were obtained with dalapon applied at the rate of 10 lb per acre and with sodium trichloroacetate (Lalicide) at 25 lb per acre. Sodium chlorate (25 lb) was appreciably less effective, but when it was followed four weeks later by treatment with Atrazine (10 lb) the strips were kept free of weeds for about eighteen weeks. The combined treatments with sodium chlorate and Atrazine, however, were not noticeably more effective than treatment with either dalapon (10 lb) or sodium trichloroacetate (25 lb).

For routine control of weeds along planting rows the choice of a suitable alternative to sodium arsenite will depend on the species of weeds present, while the frequency of application required for satisfactory control of weeds will depend on the weedkiller used and on the degree of overhead shade provided by the rubber. Judging by the results of small scale trials carried out during the year, the following herbicides may be considered suitable under the different conditions specified:

<i>Paspalum conjugatum</i> dominant	Aminotriazole 10 lb/acre or mixture of sodium chlorate 20 lb/acre and aminotriazole 5 lb/acre.
Mixed grasses including <i>P. conjugatum</i> and <i>A. compressus</i>	Mixture of dalapon 5 lb/acre and aminotriazole 5 lb/acre.
<i>Axonopus compressus</i>	Dalapon 10 lb/acre or TCA (Lalicide) 25 lb/acre.

Aminotriazole, dalapon and TCA are essentially grass eradicates and for this purpose they are more persistent than sodium arsenite and sodium chlorate; they are therefore applied less frequently than the latter compounds when the main purpose is to control growth of grasses. Invasion by small, broad leafed herbaceous growths may occur before the second and subsequent rounds of spraying for control of grasses are required, in which case intermediate spraying rounds with a weak solution of sodium salt of 2,4-D (Fernoxone) may be necessary.

Bracken. Small scale trials were carried out involving treatments with dalapon, aminotriazole, Fernoxone (sodium salt of 2,4-D), Floroxone (mixture of the esters of 2,4-D and 2,4,5-T) and Weedone Brackcontrol for control of bracken (*Gleichenia linearis*). Dalapon and aminotriazole were relatively ineffective when applied at rates below 20 lb per acre while Fernoxone was completely ineffective. The best results in these trials were obtained with Floroxone applied at the rate of 4 pints in

100 gallons of water per acre and with Weedone Brackontrol at the rate of not less than 12 pints in 100 gallons water per acre.

Ground Covers

Results of experiments in progress, commenced in 1957, show that trees grown in association with ground covers composed of legume creepers girthed at a greater rate in the second year after planting than trees grown in association with grasses, *Mikania scandens* or mixed upright indigenous growths. The greater beneficial effect of the legume cover was reflected also in the increased nitrogen and phosphorus contents of the rubber leaves. The results of chemical analysis of green material and litter underneath the different ground covers confirm that legume creepers build up appreciably larger reserves of nitrogen than the other covers.

In the four experiments designed to compare direct manuring of rubber (application in the cleared planting rows) with indirect manuring via the ground cover, few fertiliser responses in terms of tree growth are as yet evident. Positive responses to applications of ammonium sulphate have been obtained in one experiment on coastal alluvial soil and in another on an inland sandy loam, and this response was the same for both methods of application, that is direct and indirect manuring. In a manganese-deficient area, application of manganese sulphate in the planting row (direct manuring) resulted in a two-fold increase in the manganese content of rubber leaves; a small increase was also noted where the fertiliser had been applied to the legume cover, but application of manganese sulphate to grass and *Mikania* covers had a negligible effect on the manganese content of the rubber leaves in the same period.

Nutrition of Leguminous Ground Covers

Results are available from one of the three small scale trials designed to study the effect of inoculation and of applications of molybdate and phosphate fertilisers on the growth of mixed leguminous creepers. Inoculation and molybdate applications had no effect, but marked responses to phosphate fertilising were recorded. The levels of application of rock phosphate compared are 0, 1 and 2 cwt per acre per annum. In the first six months after the seed was sown, growth in the 'no phosphate' plots was poor but at the end of the first year there was little visual difference between treatments, while at the end of the second year from planting it appeared that the highest level of phosphate application was actually depressing the growth of the cover. Sampling of the plots confirmed the visual assessment, but it was observed that the quantity of plant litter under the cover was higher in the plots receiving phosphate and that application of phosphate favoured the development of surface roots. Samples of the green material and litter were analysed and the results show that application of phosphate increased the nitrogen, phosphorus and calcium contents of both green material and litter, an effect which will ultimately benefit the nutrition of the rubber.

SOIL INVESTIGATIONS

Nitrogen Studies

Only a limited amount of work on nitrification processes was carried out during the year but the results of one experiment are of interest and point the way to further work. Samples of the 0-3 and 3-9 in. layers of soil were taken from a

small scale experiment, comparing conditions in bare soil with those under different cover plants. The samples were then incubated for four weeks. Ammonium- and nitrate-nitrogen were determined at the beginning and end of this period and the results show that soil from the bare plots contained higher initial levels of nitrate-nitrogen than did soil from under the various cover plants. During incubation, however, nitrification was more rapid in the latter samples. A slower rate of nitrification was found in soils under a cover of grasses than in soils under the other covers, both in the surface and sub-surface layers. Levels of ammonium-nitrogen were initially higher in the 0-3 in. layer than in the 3-9 in. layer, with little difference between the soils under the various cover plants, but this position was reversed during incubation as a result of the nitrification which occurred.

These results are from one experiment only but they have received some confirmation from other work which has shown the existence of appreciably higher levels of nitrate-nitrogen in bare soil than in soil under various cover plants. As nitrate-nitrogen is easily leached from the soil it can be seen that cover plants are likely to conserve the soil nitrogen reserves.

Further work on mineralisation of nitrogen in plant litter and the effect of soil temperature and moisture on nitrification processes in the soil has given results confirming previous work reported in the *Annual Report 1958*.

A study of the fluctuation of ammonium- and nitrate-nitrogen in the clean-weeded planting strip in a new planting (jungle planting) on Rengam Series soil has been terminated. Over a three months' period, from August to November, samples of the 0-3 and 3-9 in. layers of soil were taken at fortnightly intervals. Levels of nitrate-nitrogen in the surface layer varied between 60 and 15 p.p.m., the level falling steadily through this range between mid-September and mid-November with the onset of the wet season. In the 3-9 in. layer, a fairly constant level of about 20 to 25 p.p.m. of nitrate-nitrogen was found. Levels of ammonium-nitrogen were lower and fell in the range 25 to 8 p.p.m. in the surface layer, with the minimum occurring in mid-November, as with the nitrate-nitrogen. In the 3-9 in. layer the level of ammonium-nitrogen remained steadily at a level of about 7 p.p.m. This work will be continued and an attempt made to determine the extent to which fluctuations depend on rainfall conditions.

Further sampling of cover plant material, litter and soil in field experiments involving a comparison of different types of ground covers was carried out. The results again show appreciably greater build-up of readily available nitrogen under the leguminous creeping covers than under the other types of ground covers including grasses, *Mikania scandens* and indigenous upright growths.

Leaching of Soil Nutrients and the Effect of Fertilisers on the Soil

As the beginning of a project to study the long-term effects of fertiliser applications on the soil, soil samples taken from each plot of several field experiments were analysed. The most important effect shown was a marked depression in pH value and in the level of exchangeable cations, particularly calcium, resulting from applications of ammonium sulphate. In one area the depression in pH value was directly proportional to the amount of ammonium sulphate applied over the previous twelve-year period. In another set of plots where ammonium sulphate had been applied annually at the rate of 3 cwt per acre for nine years, the depression was of the order of one pH unit.

The content of exchangeable calcium in the soil was depressed by applications of ammonium sulphate and increased by applications of rock phosphate. Exchangeable magnesium, which was initially low in the test area, was further depressed by applications of ammonium sulphate. As would be expected, the level of exchangeable magnesium was increased following applications of magnesium limestone while applications of muriate of potash increased soil exchangeable potassium. Treatment with rock phosphate increased the content of 'available' phosphate as determined by extraction with ammonium fluoride. Most of these effects were reflected in the nutrient content of the rubber leaves sampled in the same experimental areas.

Phosphate Studies

Laboratory work involved a study of methods of fractionating soil phosphate. After considerable exploratory work, a simple system of fractionation has been adopted as follows:

1. Acid-soluble and adsorbed phosphate extracted by ammonium fluoride
2. Organic phosphate extracted by caustic alkali
3. Total phosphate extracted by hot digestion with perchloric and sulphuric acids

The method is being applied to a study of the phosphate status of different soil types.

Results of field experiments in young and mature rubber areas have shown no noticeable difference in response to treatment with rock phosphate and superphosphate. A pot experiment was carried out to study in more detail and under controlled conditions the relative effects of these two phosphatic fertilisers on the growth of young rubber seedlings. Measurements of total dry weight, height, girth and leaf area of rubber seedlings grown in large pots filled with Kedah Series soil were recorded eleven months after sowing, when the experiment was terminated.

Averaging results for all treatments, including different methods of application, superphosphate was generally more effective than rock phosphate. The best results with rock phosphate were obtained by broadcast application in the absence of lime while 'pocket' application in the presence of lime was the least effective. Liming suppressed the effect of rock phosphate whether it was broadcast on the surface, pocketed or mixed with the soil. The response to superphosphate, however, was generally unaffected by liming. For superphosphate, pocket application proved to be the most effective and broadcast application the least effective of the three methods. The superiority of pocket application of superphosphate over broadcast application of rock phosphate in the absence of lime was not established with confidence. The conclusions are in accord with the results of earlier field experiments comparing the soluble and insoluble phosphates, in that no advantage was obtained by using the more expensive superphosphate when the method of application was the one normally used in the field, i.e. broadcasting.

PLANT INVESTIGATIONS

Methods and Techniques

A simple method for estimation of nitrogen in plant tissue by direct nesslerisation of the kjeldahl digest has been successfully worked out and compared with the

standard distillation method. A critical investigation of the nessler reaction has resulted in the formulation of a satisfactory aqueous reagent. Using this reagent along with gum arabic, which protects the ammonia-colour-complex from flocculation, a procedure has been developed for directly nesslerising the kjeldahl digest. The method is comparable in accuracy and precision to the more laborious distillation-titration method. A paper on this subject has been prepared for the *Journal of Applied Chemistry*.

Other laboratory techniques in use which have been critically examined include the rapid digestion of plant samples for analysis. Results obtained suggest that nitric acid, which has been used hitherto, may be conveniently replaced by a perchloric-sulphuric acid mixture which is less objectionable. This would have the added advantage of facilitating the direct determination of calcium by the flame photometer making unnecessary its preliminary precipitation as oxalate which is a time-consuming process.

The method for determining rubber hydrocarbon in plant tissues was examined and checked for accuracy. The gravimetric method used at present required two days for completion of a determination. A more rapid volumetric method based on bromination of the rubber hydrocarbon has been worked out and applied to the analysis of rubber crepe. The application of the method to the estimation of rubber hydrocarbon in plant tissues has presented a number of problems which have not yet been resolved. Work on this subject is continuing.

Study of the Mineral Composition of Foliage and Latex

The investigation of the effects of applications of fertilisers to the soil on the mineral composition of leaves and latex has been continued.

In the first experiment (Clone PB 86, 1948 replanting), further significant effects of applications of sulphate of ammonia in increasing the nitrogen content of the leaves, and of muriate of potash in increasing the potassium content, were observed at eight months after the first application of fertilisers. These effects were first detected at three weeks and were maintained over the first eight months after fertiliser application. There were indications that the phosphorus content of the leaves was increased by the application of rock phosphate eight months previously and that treatment with sulphate of ammonia resulted in a reduction of the calcium content of leaves and an increase in the potassium content of the latex.

In the second experiment (Clone Tjir 1, 1949 replanting) consistent positive effects of sulphate of ammonia on the nitrogen content, and of muriate of potash on the potassium content of the leaves were again observed throughout the twelve-month period following the second application of fertiliser and up to at least five months after the third application. A further effect of the treatment with sulphate of ammonia was to reduce both the calcium and potassium contents of the leaves, while treatment with muriate of potash reduced the magnesium content of the latex. No consistent effects of rock phosphate on the phosphorus content of leaves and latex were observed, although there were indications of a positive effect on the phosphorus content of leaves at ten months after the second application and again at five months after the third application of fertilisers.

In the third experiment (Clone RRIM 501, 1949 planting) the results of a further series of sampling in the period four to twenty months after the application of

fertilisers in 1958, which was the sixth application since 1954, showed marked effects of fertiliser treatment on the mineral composition of the leaves; the nitrogen content was increased and the potassium content reduced by applications of sulphate of ammonia, the potassium content increased and the magnesium content reduced by applications of muriate of potash, while both the phosphorus and calcium contents of the leaves were increased by applications of rock phosphate.

The investigation of the effect of field applications of manganese and copper salts on the mineral composition of leaves and latex has also been continued. On trees showing visual symptoms of manganese deficiency, the application of manganese sulphate at the rate of 4 and 8 oz per tree resulted in a marked increase in the manganese content of leaves, bark and bark scrap, but only a small increase in the manganese content of latex. Only very small effects of copper sulphate applications have been observed; there were indications of an increase in the copper content of both leaves and latex at four months after the second annual application of copper sulphate at the rate of 3 oz per tree.

The investigations mentioned above form a part of a programme to study a technique for determining fertiliser requirements of rubber based on the results of analysis of leaves and latex, a technique known as 'physiological diagnosis', developed and applied by M. Beaufils of the Institut des Recherches sur le Caoutchouc au Vietnam. Following a visit to Vietnam to discuss details of the technique with M. Beaufils, a more direct approach to the study of the problem was initiated during the year. A survey sampling of leaves and latex in monoclonal blocks of clones RRIM 501, PB 86, Gl 1 and Tjir 1 on estates in Selangor was started with the object of studying the relationships between the performance of the trees and the mineral composition of the leaves and latex, and also of characterising the four clones with respect to their mineral status. Over a hundred samples have already been collected from different units totalling approximately 4000 acres. The fertiliser requirements in each unit, based on physiological diagnosis, were determined and the main requirements indicated so far have been for phosphate and nitrogen in that order, followed by magnesium and potassium. Manganese deficiency symptoms have been observed on several of the estates in Selangor.

Following the survey sampling, twelve pilot trials have been laid down in selected areas to investigate both the validity of the method of physiological diagnosis and also the effectiveness of fertiliser applications to mature rubber. In addition to these pilot trials, four controlled factorial experiments involving fertiliser treatments as indicated by physiological diagnosis have been laid down.

Total Mineral Contents of Whole Trees

The study of the total mineral content of whole trees, varying in age between one and nine years, is still in progress. Analysis of the samples collected is not completed and is being carried out as and when time permits. A few results may be reported in the interim. For trees four and five years old, the leaves constitute less than 10% of the total dry weight of the tree. The total contents of the more important nutrient elements in the leaves, expressed as a percentage of the total contents in the whole tree, are: nitrogen 20-25%, phosphorus 15-20%, potassium 15-20%, magnesium approximately 15%, calcium approximately 15% and manganese 25-35%.

POT SAND CULTURE EXPERIMENTS

Effect of Micro-nutrient Status on Growth, Mineral Composition and Rubber Formation

The pot experiment designed to study the effects of three rates of application of boron ($B_0 = 0.001$ p.p.m., $B_1 = 0.1$ p.p.m. and $B_2 = 0.5$ p.p.m.) on growth, mineral composition and rubber concentration of *Hevea* seedlings was concluded at eleven months after sowing of seeds.

Boron deficiency symptoms developed only in the B_0 plants after three and a half months. These were manifested by the death of the apical growing point followed by the formation of numerous side shoots at about five months. Boron deficiency also resulted in a reduction in the height of plants. A noticeable and unexplained visual effect of a high rate of application of boron (B_2) was the development, in the lower leaf whorls, of symptoms similar to those observed in potassium deficient plants. However, the potassium content of such leaves was not low and was, in fact, higher than that of corresponding leaves of plants receiving boron at the lower rates.

Boron deficiency resulted in only a slight reduction of total dry weights of plants up to four months after sowing. The effect became more marked later and after eleven months boron deficiency had resulted in 27% reduction in dry weight.



Some pot-culture experiments on *Hevea* seedlings in an extension to the glass-house erected in 1959.

Despite wide differences in the concentration of boron in the laminae, only a small effect on the concentrations of rubber and carbohydrates was recorded. A deficiency level of boron was associated with a slightly increased concentration of rubber hydrocarbon, mainly in the laminae, and a slightly decreased concentration of hydrolysable carbohydrates. This decrease in concentration of carbohydrates in *Hevea* seedlings was noted on all four sampling occasions in the period up to eleven months after sowing of the seeds; it is unlike the effect on other plants in which an increase in concentration of carbohydrates resulting from boron deficiency has been reported.

Requirements of the Rubber Plant for Nutrient Elements at Different Stages of Growth

An investigation of the requirements of rubber seedlings for phosphorus, potassium and calcium during the first ten months of growth was carried out. This study was similar to that on relative requirements for nitrogen, phosphorus, magnesium and manganese reported previously (*Annual Report 1958*).

A retardation in plant growth was first indicated by the height measurements recorded seventy days after sowing, when a 10% reduction in height was observed in the calcium deficient plants. No reduction in height was recorded in the potassium and phosphorus deficient plants at this stage. Sampling done at 77 days after sowing showed a 50% reduction in total dry weight of calcium deficient plants. A dry weight reduction of 15% and 6% in the phosphorus and potassium deficient plants respectively was recorded when sampling was done 115 days after sowing. A 15% reduction in dry weight due to potassium deficiency was only noted 148 days after sowing.

The results indicate that young rubber seedlings require an external supply of calcium before phosphorus, which in turn is required before potassium. It is interesting to note the length of time that elapses before young rubber seedlings benefit from external supplies of nutrient elements.

Nutrient Deficiency Symptoms in Leguminous Cover Crops

The pot culture work carried out to identify nutrient deficiency symptoms exhibited by *Calopogonium mucunoides* was completed. Characteristic symptoms of deficiency of all the essential nutrient elements were observed, recorded and photographed. This completes the study of visual symptoms shown by the three legume creepers most commonly used as ground covers in rubber areas. A full report of the findings will be prepared for publication.

ADVISORY

Most of the routine advisory work of the Soils Division was taken over by the Estates Advisory Service on 1 January 1959. Thereafter, research officers of the Soils Division dealt only with the more technical subjects of enquiry and with enquiries involving laboratory analysis or examination of fertiliser, leaf and soil samples. Close contact was maintained with the Head of Estates Advisory Service who consulted officers of the Soils Division on matters arising out of advisory

Soils Division: Advisory

correspondence; joint visits were made to estates on occasions, depending on the nature of the enquiries.

The statistics relating to advisory work carried out by the Division during the year are as follows:

Letters and Interviews

Advisory letters and reports despatched ...	...	...	...	...	...	332
Advisory visits to estates ...	...	...	...	...	...	82
Interviews at the Institute ...	...	...	...	...	...	132

Samples Analysed

Soil ...	...	...	...	...	...	...	...	...	161
Plant ...	...	...	...	...	...	...	...	...	82
Fertilisers ...	...	...	...	...	...	...	...	...	42
Others ...	...	...	...	...	...	...	...	...	2

The Head of Division, the Soils Chemist (Dr G. A. Watson) and the Agronomist (Mr J. Bolton) gave talks on soil topics, cover plants and fertilisers to Senior Estate Conductors, Rubber Instructors and students attending courses of instruction at the R.R.I. Experiment Station. The Soils Chemist also gave lectures to the Tanjong Malim Branch and the Seremban Branch of the Incorporated Society of Planters. The usual assistance was given to the Technical Education Scheme of the Incorporated Society of Planters by setting questions and marking papers for the Soils Section of the Agricultural Science Examination held in February and August.

G. OWEN
Head of Soils Division

Botanical Division

The Head of Division (Mr C. W. Brookson), was on leave from 26 February to 15 July. Ir P. de Jonge acted during his absence. The latter left on long leave from 19 December and was absent at the end of the year. Dr P. R. Wycherley went on long leave from 28 July and was absent at the end of the year. Dr B. R. Buttery joined the Division on 18 August as a Research Officer, Division A. Dr S. G. Boatman went on long leave on 23 April and resumed duty on 30 October. Mr J. M. Ross, Ir. E. C. Paardekooper, Dr J. K. Templeton, Mr G. H. Tinley, Mr T. V. Vaidyanathan, Mr M. M. Chandapilla and Mr P. D. Abraham were on duty throughout the year. At the end of the year, Mr C. F. Arlett, at present studying for the degree of Ph.D., was provisionally appointed as Research Officer, Division A. He is to organise and lead the special unit to be established at the Imperial College of Tropical Agriculture in Trinidad.

Two vacancies for Research Officers Division B were unfilled at the end of the year. Candidates had been interviewed in Malaya and a special interviewing board set up in India. One vacancy is for a cytologist required for work connected with the breeding programme, the other for an anatomist.

Overseas Visits

The Head of Division visited East Malling Research Station twice to see the Director (Dr F. R. Tubbs), Mr R. J. Garner, Dr B. R. Buttery (under training) and to observe work in progress.

Other visits were made by the Head of Division to the John Innes Horticultural Research Station to discuss projected work in Trinidad with the Director, Dr K. S. Dodds; to Messrs Murphy Chemicals Ltd., to discuss the use of bactericides for yield stimulation; and, accompanied by Dr S. G. Boatman, to the Department of Agriculture, University of Oxford, to consider work on labelled yield stimulation compounds.

The Head of Division, Ir de Jonge, Dr Boatman and Dr Wycherley also made a number of visits to the London Advisory Committee, in connection with Agricultural Sub-Committee meetings, engagement of staff and work to be done in Trinidad.

Dr Wycherley visited the Herbarium of the Royal Botanic Gardens at Kew and made some observations concerning specimens of interest covering the work of the Institute.

Dr Boatman spent a week at the Department of Agriculture, University of Oxford, to examine work with labelled compounds.

Visits to Estates

Research Officers made 107 visits to estates in connection with research work of the Division; some advisory work was included in most of these visits.

Research Officers made 422 visits to the R.R.I. Experiment Station.

Field Assistants made 298 visits to trials on estates where they spent a total of 835 days.

Laboratory Accommodation

With the completion of the new building at Kuala Lumpur, three laboratories, an herbarium, three offices, a special microscope room and a dark room were brought into operation. At the R.R.I. Experiment Station a new building was occupied containing three laboratories, one air-conditioned laboratory, two temperature-controlled dark rooms, one oven and preparation room, and five offices.

Research Papers and Publications

The Head of Division and Dr Boatman attended the 1er Congrès Mondiale de la Recherche Agronomique in Rome, during May. The following papers were presented :

- | | |
|-----------------|---|
| C. W. Brookson. | Seedlings and Clones of <i>Hevea brasiliensis</i> . |
| S. G. Boatman. | Stimulation of Latex Yield in <i>Hevea brasiliensis</i> . |

The opportunity was taken to visit the Headquarters of the Food and Agricultural Organisation of the United Nations.

Dr P. R. Wycherley presented a paper on 'Seed Germination of some Tropical Legumes' at the IX International Botanical Congress at Montreal during September. He also prepared a contribution 'The Singapore Botanic Gardens and Rubber in Malaya' for the Centenary number of the Singapore *Gardens Bulletin*; also a report on the Darwin Centenary and Linnean Bicentenary held at the University of Malaya for the Malayan Nature Society.

An article 'Breeding and Selection in *Hevea brasiliensis*' was prepared by Mr J. M. Ross and published in the December issue of the *Planter*.

The following paper was published in the *Journal of the Rubber Research Institute of Malaya*, 1959, Volume 16:

- | | |
|----------------|---|
| H. M. Burkill. | Large Scale Variety Trials of <i>Hevea brasiliensis</i>
Muell-Arg. on Malayan Estates 1934-53. |
|----------------|---|

The paper 'A Report on the R.R.I.M. Exchange Clones Trials (1954 Collection)' by E. C. Paardeckooper was published as *Document 11* of the *Research Archives of the Rubber Research Institute of Malaya*.

The following articles were published in *Planters' Bulletin* :

Critical Interpretation of Yield Records — Editorial	<i>Planters' Bulletin</i>	40
Planting Recommendations 1959-60	" "	40
Natural Root Graft	" "	40
Rooted Clones	" "	40
Research and Efficiency — Editorial	" "	41
RRIM 600 Series Clones	" "	41
Direction and Slope of Tapping Cut	" "	41
Planting Material for Sale	" "	41
Chromosomes of <i>Hevea brasiliensis</i>	" "	41
Foreign Exchange Clones — 1954 Collection	" "	42
Assessment of the Growth of Clone RRIM 501	" "	43
Wind Damage	" "	43
Ladder Tapping of Budded Trees : Height of Opening	" "	43

Stimulation of the Yield of Rubber Trees as a Routine Estate Practice	<i>Planters' Bulletin</i>	45
Developments in the Propagation of <i>Hevea</i>	" "	45
Wind-damage, PB 86 and P.B.I.S.G. Clonal Seedlings	" "	45
<i>Stylosanthes gracilis</i> as a Ground Cover	" "	45
Revision of Planting Recommendations 1959-1960	" "	45
RRIM 500 and 600 Series Clones, Clones LCB 1320 and Exchange Clones: Sale and Export	" "	45

RESEARCH

BREEDING AND SELECTION

Hand Pollination

The hand pollination programme for 1959 differed from previous programmes in that one large family (selected from a previous exploratory family) and several exploratory families were planned. It was intended that the large family (RRIM 501 $\times$ RRIM 623) should comprise at least 1,000 seedlings and, to supply these, 10,226 pollinations were made. In addition, 1,419 pollinations were made of the reciprocal cross.

The exploratory crosses were made between clones RRIM 501, RRIM 614, RRIM 623, RRIM 632 and LCB 1,320, the object being to obtain at least 100 seedlings of each cross. Where possible, the reciprocal crosses were made.

The inbreeding programme was continued by making 4,227 pollinations of the family RRIM 501 selfed.

A subsidiary programme consisted of crosses of RRIM 501 with five clones of *Hevea brasiliensis* made from seed of Peruvian origin. A total of 30,411 hand pollinations were made.

The results of the programme, which commenced on 2 February and ended on 4 April, are set out in the Table opposite.

Counts of all fruit set were made twice between 20 March and 20 June in order to discover at what stage of development the greatest proportion of immature fruit is lost. The data obtained from two of the crosses, RRIM 501 $\times$ RRIM 623 and RRIM 501 selfed, are given below:

LOSS OF FRUIT DURING MATURATION

Cross	No. of hand pollinations	% success at first count	% success at second count	% success at harvesting
RRIM 501 $\times$ RRIM 623	10,224	27.4	8.9	8.7
RRIM 501 selfed	4,277	24.1	7.8	7.5

RESULTS OF THE 1959 HAND POLLINATION PROGRAMME

Family	No. of pollinations	No. of fruits harvested	% of pollination success	No. of seeds planted	No. of seeds germinated	% of germination success
1. RRIM 501 × RRIM 623	10,226	893	8.7	2,663	1,785	67.0
2. RRIM 501 selfed	4,277	320	7.5	957	806	84.2
3. RRIM 623 × RRIM 501	1,419	35	2.5	108	91	84.3
4. RRIM 501 × LCB 1320	1,155	81	7.0	242	131	54.1
5. RRIM 501 × RRIM 628	1,231	74	6.0	223	122	54.7
6. RRIM 501 × RRIM 614	958	89	9.3	267	186	69.7
7. RRIM 614 × RRIM 501	310	53	17.1	158	30	19.0
8. RRIM 501 × RRIM 632	1,137	69	6.1	208	146	70.2
9. RRIM 628 × RRIM 632	1,034	64	6.2	192	139	72.4
10. RRIM 628 × RRIM 614	1,238	75	6.1	227	160	70.5
11. LCB 1320 × RRIM 632	1,134	37	3.3	111	92	82.9
12. LCB 1320 × RRIM 628	960	68	7.1	204	113	55.4
13. LCB 1320 × RRIM 614	1,062	100	9.4	304	158	52.0
14. RRIM 614 × LCB 1320	112	21	18.8	62	—	—
15. RRIM 501 × Peruvian <i>H. brasiliensis</i> 1	157	9	5.7	27	27	100.0
16. Peruvian <i>H. brasiliensis</i> 1 × RRIM 501	314	35	11.1	105	83	79.0
17. RRIM 501 × Peruvian <i>H. brasiliensis</i> 2	1,263	97	7.7	290	204	70.3
18. Peruvian <i>H. brasiliensis</i> 2 × RRIM 501	114	12	10.5	36	35	97.2
19. Peruvian <i>H. brasiliensis</i> 3 × RRIM 501	525	—	—	—	—	—
20. RRIM 501 × Peruvian <i>H. brasiliensis</i> 4	893	70	7.8	209	184	88.0
21. RRIM 501 × Peruvian <i>H. brasiliensis</i> 5	699	38	5.4	114	103	90.4
22. Peruvian <i>H. brasiliensis</i> 5 × RRIM 501	193	6	3.1	18	18	100.00
<i>Total</i>	30,411	2,246	7.4	6,725	4,616	68.6

In the case of the pollinations made before 16 March, virtually no losses occurred after 30 May when the second count was made. In the case of pollinations made after 16 March, the first count was made on 15 May by which time almost all of the losses had occurred. It is therefore clear that the bulk of the losses occurred between the beginning of April and the middle of May.

The final percentage of harvesting success varied from 18.8 (RRIM 614 $\times$ LCB 1320) to nil (clone of Peruvian *H. brasiliensis* 3 $\times$ RRIM 501) but the success in the various families cannot be directly compared as the crosses were made at different periods during the season. For example, the final success of the family RRIM 501 $\times$ RRIM 623 was 8.7% while that of its reciprocal was 2.5%. The bulk of the pollinations in the former were made at the beginning and in the middle of the season (which lasts from February to April), whereas those of the latter were made at the end of the season when successes were, in general, lower.

The final harvesting successes in both of the families in which RRIM 614 was the female parent were high: 17.1% in RRIM 614 $\times$ RRIM 501 and 18.8% in RRIM 614 $\times$ LCB 1320. These high figures are not due to a higher proportion of fruit set but to a smaller loss of developing fruit. The poor germination of seed of the first of these families and the lack of germination in the second were due to light and rotten seeds at the time of harvest.

The percentage fruit set and the success at harvesting in family RRIM 501 selfed is about the same as in RRIM 501 $\times$ RRIM 623.

The germinated hand-pollinated seeds were planted in a specially prepared nursery in Field 2 at the R.R.I. Experiment Station. Seedlings grown from seed collected in monoclonal areas of clone Tjir 1 were also planted in the nursery for comparison. Pollen of clones FX 25 and RRIM 623 was supplied to Prang Besar Estate.

Seedling Families

Seedlings from the 1947 hand pollination programme completed the fourth year of tapping in September 1959. The highest yielding families continue to be RRIM 501 (Pil A44 $\times$ Lun N) $\times$ Tjir 1 and RRIM 507 (Pil B84 $\times$ Pil A44) $\times$ Tjir 1, with respective mean yields of 35 and 37 grams of dry rubber per tree per tapping over four years, compared with 28 grams per tree per tapping from the control, Tjir 1 illegitimate seedlings.

Seedlings from the 1948 hand pollination programme completed the third year of tapping in June 1959. The highest yielding families continue to be 33/520 (Tjir 1 $\times$ PB 24) $\times$ RRIM 501 (Pil A44 $\times$ Lun N), 44/553 (Tjir 1 $\times$ Pil B84) $\times$ RRIM 501, and RRIM 623 (PB 49 $\times$ Pil B84) $\times$ RRIM 501, with respective mean yields of 54, 51 and 48 grams of dry rubber per tree per tapping over three years, compared with 21 grams per tree per tapping from the control, Tjir 1 illegitimate seedlings.

Seedlings from the 1949 hand pollination programme completed the second year of tapping in March 1959. None of the families is showing promise of particularly high yields.

The trial of the 1951 hand pollinated seedlings was brought into tapping in October. The mean girths of the families Lun N selfed and RRIM 605 selfed are above the average for the trial.

Clones

Further initial selections of clones resulting from the 1947 and 1948 hand pollinations have been made. Clones are now being multiplied, from which the final choice will be made for the large scale trial to be set up on the Experiment Station in 1960.

A small scale trial of clones made from the 1957 hand pollinated seedlings grown in Field 62B at the R.R.I. Experiment Station was budded in Field 62C in April and May. A simple lattice design was used. Owing to the shortage of land, only the most vigorous half of the seedlings in each family was cloned. The total number of new clones is 445. All the seedlings, whether cloned or not, were cut back by the end of June.

The small scale trial in Field 51D of the clones made from the 1950 hand pollinated seedlings was brought into tapping in January. One clone is outstanding as a yielder and budwood from it is being multiplied so that its performance as a mature type budding can be ascertained as early as possible.

Seed Storage

A further small trial in which fresh seed of *Hevea brasiliensis* was coated with shellac indicated that there is no likelihood that such treatments will prolong the viability of the seed. All seeds were stored in sealed polythene bags at ordinary room temperature and the untreated control series gave 62% germination (initial viability 74%) even after seven weeks of storage.

Tjir 1 seeds were stored in polythene bags in a cold room at 40°F and at room temperature and samples removed at intervals for germination. After 12 weeks of storage, 68% germinated in the former and 62% in the latter storage treatment. Initial viability was 89%.

These experiments will be continued.

TRIALS OF SELECTED PLANTING MATERIAL ON ESTATES

Projected Trials

In the year under review, sites were chosen and plots demarcated for two large scale trials, one at the R.R.I. Experiment Station to test new RRIM selections, and one clone trial combined with a tapping experiment on an estate, to compare the most promising exchange clones and other clones on two different tapping systems.

Pre-war Trials

The number of recorded pre-war trials, which was sixteen at the beginning of the year, was reduced to nine by the end of 1959. High tapping was started in two of these trials and will be introduced in another four in the course of 1960. In one trial, clones RRIM 501 and 513 gave very high yields when tapped high.

During the period under review, a number of reports were received of serious *Gloeosporium* attack on clone RRIM 526, mainly in the immature stage. Susceptibility to *Gloeosporium* appears to be a clonal characteristic.

Post-war Trials

The number and age of post-war trials at the end of 1959 was as follows :

NUMBER OF POST-WAR TRIALS

Trials	Mature, in tapping for :				Immature			Total no. of trials
	3 yrs or more	2 yrs	1 yr	Less than 5 yrs	Older than 5 yrs	3-5 yrs	0-3 yrs	
Distributed block trials (RRIM 600 series)	1	8	9	1				19
Complete, RRIM 500 series	1	1						2
Complete, RRIM 600 series	2		10	6	4	11		33
New clones (mixed)		2	1		1	2		6
Exchange clones						1	5	6
Clonal seedlings							1	1
<i>Total</i>	4	11	20	7	5	14	6	67

This table includes six trials at the R.R.I. Experiment Station and three so-called observation areas. One distributed block trial was closed down because of wind-damage. There were forty-two trials in tapping and twenty-five immature trials.

The results of the fourth year of tapping of clones RRIM 600-618 and the third year of clones RRIM 619-630 in the trials at the Experiment Station are to be published in *Planters' Bulletin* 46, January 1960.

Clone RRIM 628 continues to yield very highly and is added to the list of promising clones. RRIM 600 showed a considerable increase in yield during last year; unfortunately this clone has a bulging tapping panel. Clones RRIM 603 and 610 were deleted from the list of promising clones.

A complete review of the results of the estate trials is in preparation. The yields for the first year of tapping have been summarised and the following table indicates the yield level of the clones under testing in all large scale trials (yield per tree).

YIELD PER TREE OF CLONES IN LARGE SCALE TRIALS, AS A PERCENTAGE
OF RRIM 501

Percentage of RRIM 501 in 1st and 2nd year of tapping	Clones
145%	RRIM 628(5)
125%	RRIM 527(3), 624(2), 626(1); PB 5/63(5)
115%	RRIM 605(5), 613(1), 614(1)
110%	RRIM 610(2), 623(5); PB 5/51(5)
100%	RRIM 600(5), 616(1), 621(1), 629(4); PB 5/37, 24/3
95%	RRIM 603(1), 607(5), 630(4); PB 9/82
90%	RRIM 609, 617, 618, 625, 627; PBT 495
85%	RRIM 526, 620, 622; LCB 1320
80%	RRIM 604, 606
75%	RRIM 601, 611, PBT 481
70%	RRIM 608, 615, 619; PR 107; PB 86
60%	RRIM 602, 612; PB 24/51

(1) Discarded because of wind damage. (2) Yields show a sharp decrease in third year. (3) Discarded because of wound reaction. (4) Poor growers. (5) Remaining on the list of promising clones.

The 'Jugra Land and Carey Island' clones which occur in one trial only have not been included in this summary. Of these clones CS 54 and SG 170 have yielded the same as clone RRIM 501 over the first two tapping years.

In one trial of clones RRIM 619–629 on coastal clay, planted in 1952, heavy wind-damage, mainly uprooting of trees, occurred over the last three years. The clones can be classified as follows:

1. Extremely liable to uprooting (more than 30% of trees): RRIM 626
2. Liable to uprooting (10–20%): RRIM 629, 624, 621.
3. Average (3–6%): RRIM 622, 627, 619, 620.
4. Resistant (less than 3%): RRIM 628, 501, 625, 623; PB 86.

Trunk snap was most frequent in RRIM 626 and 621; this is confirmed by results in other trials.

During 1959 the latex of all clones in a number of complete trials was analysed by the Chemical Division. Stability tests were also carried out and in a few trials leaves were analysed. A report will be issued in the near future.

In three trials in which clones RRIM 619–630 were tested, bark samples were taken and latex vessel rings were counted. An analysis showed significant differences between the clones and also a significant interaction of clones $\times$ trials. Although the differences between clones was rather small (total number of vessel rings varies from 15–22) there was a surprising correlation with yield; clones with the highest number of latex vessel rings were RRIM 628, 621, 624.

In the non-RRIM clones trial (one of the trials listed as 'New Clones') at the R.R.I. Experiment Station, clones LCB 1320, Nab 15 and Ch 26 were the most vigorous clones (five years from cutting back). In the RRIM 630-638 large scale trial, clones RRIM 632 and 638 were relatively vigorous.

In a number of complete trials wintering behaviour was observed. A rough classification is as follows:

WINTERING BEHAVIOUR OF CLONES

Wintering	RRIM clones	Non-RRIM clones
Early	501, 618.	PB 86; SG 146.
Rather early	526, 603, 609, 611, 624, 627 629.	PR 107; CS 51, 54, 142.
Average	527, 604, 606, 607, 608, 610 612, 615, 617, 620, 622, 623 625, 626, 628, 630.	LCB 1320; PB 5/37, 5/63 9/82; CS 101; SG 161, 163 167, 170.
Rather late	605, 614, 616, 619, 621.	
Late	600, 601, 602, 613.	PBT 495; Ch 26.

Secondary leaf fall was noted in clones RRIM 627 and SG 146. In many clones wintering was gradual and incomplete.

The first results of the exchange clones trials were summarised in a report (*Research Archives of the Rubber Research Institute of Malaya, Document 11*, October 1959). Vigorous clones (second year of life) with a straight stem and without exceptionally late branching habit were: RRIM 526, 623, 632; RRIC 5, 45; PR 251, 252; AVROS 385, 1279; TR 1406, 1514.

In October 1959, observations on *Gloeosporium* incidence were made in one trial. The following clones were relatively heavily infected:

RRIM 526, 636; PB 5/63, PB 86; PR 250; AVROS 1320;

RRIC 29, 36; IRCI 5, 6, 10.

Recording and Experimental Technique

An experiment carried out to investigate the differences in moisture content of cup lumps of different sizes has shown that the error made in assuming the same water content for lumps of various sizes is small. Correction factors have been calculated but will not be used in large scale clone trial recording. The same experiment showed that there is no reason to prolong the drying time of cup lumps above ten days, even if drying takes place on drying racks. The methods of recording at the Experiment Station have been altered accordingly. Another change is that in future cup lumps will be weighed on the wires as in the estate trials.

Three estates were provided with a new type of balance. Instructions for estate conductors in charge of yield recording were issued.

The staff of field assistants at Headquarters was re-organised. Measures were taken to improve yield recording, census taking and summarising of results. In the period under review the girth measurements of fourteen trials were recorded for the first time by the punched card system.

An analysis of the individual tree data in a number of clone trials was started to investigate problems of variability, optimum number of trees per plot, number of replications, etc.

In trials three to four years' old, no significant difference between the girth of trees at the centre and at the boundary was found. In a nine-year-old trial, planted at 20 ft $\times$ 10 ft, there was a marked 'boundary effect': for the most vigorous clone the mean girth of trees at the centre of the plots was 6% greater than at the boundary while for the three least vigorous clones the corresponding figure was 4%.

PROPAGATION AND PLANTING TECHNIQUE

Vegetative Propagation of Hevea brasiliensis

Work on vegetative propagation continued throughout the year with the object of establishing self-rooted clones of *Hevea brasiliensis*.

Following the visit of Mr R. J. Garner of the East Malling Research Station during the last four months of 1958 a number of approaches were made, including layering, air layering (marcotting), root grafting, and rooting leaf bud cuttings, hardwood cuttings and leafy cuttings.

Clonal roots were obtained by air-layering green wood shoots of a number of clones (Tjir 1, RRIM 501, 602, 607, 611 etc). In preparing the marcot, an upward slice into the stem combined with an interleaf of polythene was found to be a more effective wounding treatment than the more usual practice of removing a ring of bark. Ensuring the survival of the rooted marcot after removing it from the mother plant at first presented a problem, but this was partly overcome by the use of mist propagation to promote the establishment of roots on the severed marcot.

Several shoots grown from layered budwood stems were rooted. The shoots had previously been wounded and the wound covered with soil. There was difficulty in establishing the layered budwood stems and survival of the severed rooted shoots was poor.

No success was obtained in grafting small pieces of clonal root on to marcotted shoots or on to cuttings.

Rooted cuttings. The rooting of hardwood cuttings of a number of clones was unsuccessful; on the other hand, where similar material taken from one-year-old seedlings was used, most of the cuttings rooted.

Under mist propagation the rooting of leafy cuttings did not at first appear promising, but it was found possible to keep the leaves on the cuttings healthy in an improved environment obtained by shading the plants and by modifying nozzles and increasing pressure to give a finer spray of water.

The first successfully rooted cuttings were of clone RRIM 602 which did not receive the pre-callusing treatment recommended by Levandowsky. The ease with which such straight cuttings can be collected led to a more intensive investigation of this method of propagation.

Budwood of more clones was made available, and was cut back to produce shoots for cuttings. Budded stumps, stumped buddings, and seedlings for later budding were planted in a special nursery (Field 15 at the R.R.I. Experiment Station) to provide a future source of cuttings. Cuttings were also obtained from the tops of budwood in the nursery and from young trees and trees in tapping.

In the improved environment described above, leafy cuttings from clones PB 86 and GT 1 rooted quite readily, when 'Fermate', a fungicide, was used as a routine dip on the cut surface. Rooting commenced after about forty days in the mist frames. A mixture of sawdust and sand, 1 : 1 by volume, was found to be a suitable medium for striking the cuttings; mist was applied continuously during the hours of light.

The condition of the leaves of the cutting was found to be important; if immature the leaves do not withstand constant wetting, but if they are too mature the terminal bud may be damaged.

During the year, other clones were tested for ability to root and extreme differences were found; some rooted well, others very poorly. A high proportion of the *Hevea brasiliensis* × *Hevea benthamiana* hybrids were found to root readily. Leafy cuttings of certain clones were removed from the tops of budwood stems and successfully rooted, and, for the first time, cuttings obtained from mature trees in tapping were rooted.

Experiments on the use of growth substances were discontinued temporarily as damage to the cutting was observed in many cases, although some clones appeared more tolerant than others. Further use will be made of growth substances and other chemicals in an attempt to root clones which have not responded to treatment so far.

Establishment of the rooted cuttings in baskets and hardening off before planting out is promoted by the general use of John Innes potting composts and by gradual removal of the basketed plants from the mist. Loss of leaf during rooting and hardening off must be avoided; in cases where this occurs the cutting either dies or takes a very long time to become established. More knowledge of field establishment is required.

The growth of some of the first cuttings to be rooted in the nursery is very good. Self-rooted PB 86 trees appear to be vigorous.

To accommodate the number of shoots available for cuttings, three more 32 ft × 5 ft propagating frames were built during the year. An extension to the existing field laboratory and bins for potting composts were built. A 2,000-gallon water tank was built from which water can be automatically drawn into the mist lines in case the mains water supply fails. The original water tank is used for metering nutrient solution into the mist.

There is now no doubt that vegetative propagation of some clones of *Hevea brasiliensis* is possible on a scale at least large enough to permit their use in

stock/scion and related experiments. It has not yet been possible to induce rooting on many valuable clones but it is hoped that some of them will respond to treatment during 1960.

A total of 8150 leafy cuttings was taken during 1959 from approximately 150 different clones. More than 60% success was obtained in rooting of fifty clones on one or more occasions. Of the eight hybrid clones of *Hevea brasiliensis* and *Hevea benthamiana* which were tried, seven had a success of over 60%. The average success in rooting of clone PB 86 in thirty-three experiments during the second half of the year was 83% and of GT 1 in thirty experiments 81%. No effects of time of year on rooting have yet been seen, but attention is being paid to the nature and condition of the source of cuttings. Rooted clonal cuttings are being compared on a small scale with budgrafts. Others are being planted for later testing for root disease tolerance.

Large marcots. In 1958 numbers of budwood stems were top-worked with buds from young seedlings and some months later the clonal stems were marcotted. Similar numbers of budwood stems which were not top-worked were also marcotted.

Early in 1959 numbers of these marcots were found to be rooting. The presence of the seedling tops had no beneficial effect upon rooting of the clonal stem; there was evidence that, in general, the plants that had not been top-worked rooted better than those that had. This may have been due to the greater leaf area on the former.

Of 581 top-worked marcots, 205 rooted. Of 546 marcots which had not been top-worked, 312 rooted. The thirty clones which were used varied in their ability to root. Success ranged from over 80% with clones RRIM 617, RRIM 618, PB 86 and PR 107 to under 10% with RRIM 604, 608, 616 and 620.

The rooted marcots were transferred to baskets filled with potting compost and watered under shade. Considerable numbers failed to survive removal from the parent plant. Those which survived were planted out into observation plots and into a stock/scion experiment. In spite of considerable attention, and after a promising start, many began to die and the experiment was abandoned. It is recorded that budded stumps also failed, owing to drought and to sandy soil in the field.

Crown Budding

The established crown budding experiment continues to show a marked influence of the crown on the girth increment of the trunk. However, the nature of the trunk assumes greater importance than was detectable before. The inferior increment of Tjir 1 trunks is again shown.

These results may be compared with the stock/scion experiments on *Hevea* in which the scion appears to dominate the partnership; although the converse, i.e. stock predominance, has been established for certain tree crops in temperate regions.

The use of rootstocks which are vegetatively propagated and hence more uniform than the current seedling stocks may reveal greater effects of the stock than have hitherto been detected. Nevertheless, it is clear that stock effects are less important

in the case of *Hevea* than in tree crops in temperate climates. This may be due to the different periods of assimilation and leaf and root respiration in the tropics and temperate regions. Leaf respiration may compete more strongly with assimilation in the tropics than in temperate regions where root respiration may play a greater part.

Progress was maintained in establishing a further crown budding experiment in which clones resistant to leaf disease are being used.

Stock/Scion Experiment

The failure to establish large rooted marcots from budwood stems in a stock/scion experiment in Field 17 has been mentioned in a preceding section.

A small experiment is being established to compare PB 86, GT 1 and RRIM 605 grown from cuttings with the same clones planted as budded stumps.

Rooted cuttings of these and other clones were also planted in an adjoining area for observation.

Tolerance to Root Disease

With the object of investigating the possibility of clonal tolerance to root disease fungi, a number of trees produced by marcotting budwood stems were planted in a plot in Field 17. Unfortunately it was impossible to establish these satisfactorily. Replanting with rooted cuttings of certain clones is being undertaken in this area.

TAPPING

Full Spiral Tapping

These experiments have been reported on in the *Annual Report 1958*. Detailed results are to be published in the *Journal of the Rubber Research Institute of Malaya*.

Tapping Experiments on Planting Material Sensitive to Brown Bast

The third year of tapping of an experiment carried out on Prang Besar 'Further Proof' seedlings was completed in April 1959.

The experiment has not been down long enough to allow a fair comparison between the tapping systems employed. The following observations are of interest:

- (1) There is no significant difference in rate of girdling between trees tapped alternate daily or third daily on a half-spiral cut, during the first three years of tapping.
- (2) No drop in yield has been recorded when the tapping cuts of the alternate daily tapped trees were turned over to a new panel except during the first month of tapping of the new panel. The yield continued to increase.
- (3) The daily periodic tapping system (S/2.d/1.15d/30.100%) has yielded less than continuous alternate daily tapping (S/2.d/2.100%).

The brown bast records are biased, as the alternate daily tapped trees were tapped on a new panel during the third year of tapping, which greatly reduced the number of trees out of tapping because of brown bast. This however, is only

temporary and coming years will give a better assessment of the influence of tapping system on brown bast incidence. At the end of the third year of tapping, 4% of the alternate daily and 7% of the third daily tapped trees were affected with brown bast.

High or Ladder Tapping

There are six experiments in progress in which, among other factors, the effect of ladder tapping on yield of both budded and seedling rubber is studied.

Commercial records are regularly received from co-operating estates. The clones which gave high yields when tapped on the first high panel, repeated the yields on the second high panel in a large scale experiment carried out at the R.R.I. Experiment Station.

Records are becoming available of clonal seedlings tapped on high panels. These show that no great increase of yield is to be expected from ladder tapping clonal seedlings.

An experiment carried out on an estate has shown that the decline in yield, usually shown when a high tapping cut moves down the stem towards the renewed bark of the low panels, can be considerably postponed by opening the high cuts as high as possible. The results of this experiment have been published in an article in *Planters' Bulletin* 43 (July 1959), 'Ladder tapping of budded trees: height of opening'.

Two RRIM 500 series clones trials are being tapped on high panels above bark of first renewal. One of these will be confounded with application of yield stimulant. Results show good response of clones RRIM 501 and 513 to ladder tapping. When ladder tapped all other clones gave a yield similar or less than that obtained when they were tapped on bark of first renewal.

Intensive Tapping

The oldest experiment is carried out on budded trees of nine clones which are tapped alternate daily on two half-circumference cuts. No stimulant has been used. It was observed that the high yield per acre initially obtained through double-cut tapping is decreasing as time progresses. The high yielding clones PB 186, Pil A44, Pil B84 and Tjir 1 yielded more on a single high cut than when tapped on two cuts during the fifth year of tapping. The decreasing performance of the double-cut system sets in during tapping of the second high panel which, as a consequence of the tapping system, is surrounded on all sides by young, or at the best one-year-old, renewed bark. The effect of yield stimulant on this panel is now being tried out.

The experiment carried out on unselected seedlings shows a similar decline in yield by trees tapped alternate daily on two half-circumference cuts. Whereas the yield of these trees increased by 100% during the first six months of the experiment, compared with trees tapped alternate daily on one half-circumference cut, an increase of only 50% has been recorded during the most recent six-month period, four years after commencement of the experiment. The yield of the high cuts when the second high panel is tapped is disappointing, as in the case of the budded trees. Application of a stimulant does not result in a noticeable effect after four years of continuous half-yearly stimulation.

Annual Report of the Rubber Research Institute of Malaya, 1959

The experiment carried out on high yielding mixed buddings of eighteen years of age is yielding interesting results. A summary of the yield records is given below:

INTENSIVE TAPPING SYSTEMS. MEAN HALF-YEARLY YIELDS EXPRESSED IN GRAMS PER TREE PER TAPPING

Tapping Systems	First 6 months		Second 6* months		Third 6 months	
	grams	as % of control	grams	as % of control	grams	as % of control
1. S/2.d/2.100% low cut	34.1	100%	34.0	100%	35.5	100%
2. As (1) plus stimulant	47.6	140%	48.2	142%	45.3	128%
3. V/2.d/2.100% high cut	22.9	67%	21.2	62%	26.6	75%
4. As (3) plus stimulant	40.8	120%	37.0	109%	37.4	105%
5. 2C/2.d/2.200%	55.3	162%	54.7	161%	52.9	149%
6. As (5) plus stimulant to low cut	63.8	187%	60.7	179%	55.1	155%
7. As (5) plus stimulant to high cut	69.0	202%	65.1	191%	55.4	156%
8. As (5) plus stimulant to both cuts	77.6	228%	73.4	216%	59.5	168%

1. S/2.d/3.67% low cut	33.6	100%	36.7	100%	48.0	100%
2. As (1) plus stimulant	58.2	173%	48.4	132%	68.1	142%
3. V/2.d/3.67% high cut	17.2	51%	15.3	42%	25.1	52%
4. As (3) plus stimulant	53.9	160%	40.7	111%	58.0	121%
5. 2C/2.d/3.133%	66.3	197%	62.2	169%	80.3	167%
6. As (5) plus stimulant to low cut	88.0	262%	78.5	214%	90.0	188%
7. As (5) plus stimulant to high cut	83.7	249%	70.9	193%	86.4	180%
8. As (5) plus stimulant to both cuts	94.9	282%	88.4	241%	88.9	185%

* Abnormally dry period May – Oct. 1958

The main observation in this experiment is the marked improvement in yield of the third daily tapping systems relative to the alternate daily systems, with exception of third daily tapping of one high cut only (V/2.d/3.67%). Ladder tapping of these budded trees, which have good bark of first renewal on the low panels, has given disappointing yields.

Application of a yield stimulant gave less response on trees tapped on a high cut than on trees tapped on a low cut in bark of first renewal.

Under the conditions of the experiment, the yield of the high cut is better when a low cut is also tapped on the same tree and tapping is done third daily. This, combined with the higher yield per tapping of the low cuts, gives the third daily double-cut system (2C/2.d/3.133%) a higher yield both per tapping and per acre per year than the alternate daily double-cut system (2C/2.d/2.200%) during the third period of six months.

The effect of stimulant is decreasing after eighteen months in both 133% and 200% tapping.

Interaction between Tapping, Stimulation and Manuring

There are two experiments in progress. In one experiment alternate and third daily tapping of a half-circumference cut are being compared on clone PB 86. The alternate daily system is also confounded with the application of a yield stimulant.

The third daily tapped tasks have yielded 79% of the alternate daily tasks. The effect of the yield stimulant has been disappointing. The overall yield over the first year of tapping showed no increase due to the yearly application of a stimulant containing 0.5% 2,4,5-T; the yield reached a peak after application but dropped below that of unstimulated tasks in later months. No effect of fertiliser application has yet been observed. There is no difference in girthing between treatments so far.

In the second experiment, carried out under supervision of the research unit of a leading rubber company, three tapping systems are compared at four levels of manuring on budded trees of clone PB 86, as described in the *Annual Report 1958*.

The double-cut third daily system (2S/2.d/3.133%) in the second experiment continues to show a severe retarding effect on girth. Third daily tapping of a half-spiral cut (S/2.d/3.67%) has not induced better girthing of the trees compared with alternate daily tapping (S/2.d/2.100%). It is clear that on trees tapped on two cuts, the low cut yields significantly better than the high cut.

No effect of fertiliser application has yet become apparent.

Another experiment was commenced during the year on the site of a discontinued manuring experiment, with the object of studying the effects of long term manuring programmes on the response of trees to stimulation.

PHYSIOLOGY AND MORPHOLOGY

Yield Stimulation

New panels have been opened on clonal seedlings which have been stimulated at half yearly intervals from February 1952 onwards, in bark that has renewed after previous stimulant application.

The yield records after opening the new panel are as follows:

MEAN MONTHLY YIELDS IN GRAMS PER TREE PER TAPPING, FROM BARK RENEWED
AFTER STIMULANT TREATMENT

New panel opened	Trees stimulated with 2,4-D	Trees stimulated with 2,4,5-T	Control trees
December 1958*	29.9	32.7	27.5
January 1959	42.8	45.2	25.6
February 1959	28.2	30.2	17.8
May 1959	24.9	22.9	20.1

* No stimulant applied in December; these figures thus give the yield capacity of untreated bark of second renewal. The stimulant was applied early in January 1959.

These figures show that the yield capacity of bark renewing after stimulation is at least as good as that of the control trees. The thickness of the bark was $1\frac{1}{2}$ mm more for the stimulated trees.

Field Screening Tests of Plant Growth Substances

During the early part of 1959 there was some delay in the setting-up of the new large scale experiments. Preliminary yield recording commenced in a number of areas at the close of the year.

The following trials were carried out:

1. The two experiments set up in Field 18A R.R.I. Experiment Station at the end of 1958 to test compounds supplied by the Department of Agriculture, Oxford University, were completed in June. The results of the first experiment confirmed earlier evidence of the high activity of certain of the chlorine- and fluorine-substituted phenoxyacetic and propionic acids. The remaining treatments compared unfavourably with 2,4,5-T. The results obtained with the substituted benzoic acids tested in the second experiment were disappointing.

2. A further three compounds supplied were tested both on a small and a large scale. Their activities were not high when tested alone, but there was some suggestion of a synergistic effect when used in combination with 2,4,5-T. Further small scale trials were set up to investigate this point.

3. Other large scale experiments in Fields 18A and 20B R.R.I. Experiment Station were discontinued during the course of the year. None of the experimental mixtures tested consistently outyielded 2,4,5-T and 2,4-D which continue, despite certain disadvantages, to be the most useful plant growth substances for commercial yield stimulation.

4. A number of new commercial stimulant compounds were put under trial in Field 15 R.R.I. Experiment Station at the close of the year. No results are yet available.

5. Small scale screening of possible stimulant compounds and mixtures continued. It is hoped to give the promising combinations a more extensive trial in the coming year.

6. Co-operation with Chemical Division continued in the test of bactericides and combinations of bactericides and growth substances for yield stimulation activity. Three short-term experiments were carried out in Field 15 R.R.I. Experiment Station to screen possible stimulant mixtures and it is hoped to test a further selection early in 1960. Meanwhile, recording continued in two long-term experiments at the R.R.I. Experiment Station and in one on a co-operating estate.

Translocation of Growth Substances

Work on the bio-assay of plant growth substances was hindered by difficulties in obtaining regular supplies of good quality oat seed.

Further work on the ether-soluble substances of *Hevea* latex has confirmed the absence of 3-indolylacetic acid. Evidence has now accumulated that the active area in the chromatograms 'E 1' (Rf 0.6–0.9: solvent n-butanol/ammonia (0.880)/water in the proportions 100:3:18) referred to in earlier reports, contains more than one substance responsible for activity and indole colour reactions. Attempts were made, with some success, to fractionate the extract further.

Studies on the aqueous solution remaining after ether extraction also continued and its high activity in the *Avena* straight growth test was confirmed. The chromatograms obtained from a number of latex samples from different sources were qualitatively similar, but no further progress was made in the fractionation or identification of the substances contained in the active areas.

During the previous year, it had been shown that IAA suddenly appeared in considerable amounts in the latex obtained from trees treated with a yield stimulant containing IAA. A large rise in growth substance activity was also noted in latex from trees treated with 2,4,5-T. These experiments indicated that during the period in which yield increases were obtained, the stimulant compounds were present within the lactiferous system itself in physiologically active concentrations.

In further experiments trees were stimulated with n-butyl ester of 2,4,5-T and the ether extract of the latex was fractionated into 'acidic' and 'neutral' substances by extraction with sodium bicarbonate. It was found that there was little change in the acidic extract following stimulation but that there was a marked rise in the level of activity of the neutral extract. This suggests that 2,4,5-T was present in the latex as a neutral compound and not as the free acid. This is surprising in view of the numerous investigations, with other plants, in which it has been found that esters of 2,4-D and 2,4,5-T were hydrolysed during entry into the plant, the active material obtained by extracting the tissue being taken up quantitatively by sodium bicarbonate. In the present case, it is not yet known whether the 2,4,5-T is present as the unchanged ester or whether it has been converted to another neutral compound. It is hoped to investigate this point further.

In addition an experiment was carried out to investigate the effect of yield stimulation by copper sulphate injection. A good increase in yield was obtained but this could not be correlated with any change in the level of growth substance activity in the latex. From this it would appear that the action of copper sulphate, although superficially very similar to that of 2,4-D and 2,4,5-T, does not include changes in growth substance level and may operate either at a different stage in the same stimulatory process or by an entirely different mechanism.

Anatomy of Bark and Wood

Regular sampling of bark and counts of latex vessel rows and of stone cells penetrating the soft bark have been made during the year. A study of the anatomy of wood and liability of clones to wind damage commenced during the year under review.

Wind Damage

Observations and theories on this subject up to the end of April were summarised for publication in *Planters' Bulletin* 43, July 1959.

Seven-year-old buddings of RRIM 501, taken from the NPK manurial experiment in Field 54, were tested for timber strength at the Forest Research Institute. Initial results suggested a negative correlation between timber strength and high phosphorus and potassium applications. A study of leaf analyses of these trees showed, however, that leaf phosphorus was not correlated with wood strength, whilst leaf potassium and calcium were correlated negatively with strength. ($p < 0.01$ and $p < 0.001$ respectively).

It is important to note that the magnitude of these treatment effects on wood strength is quite small, in the order of 5 to 6% of the mean. Whether this is of any real importance in determining susceptibility to wind breakage has yet to be discovered.

Experiments to test methods of wind damage prevention have been set up by a collaborating planting company. Pollarding of the entire crown of a tree in tapping appears to have been responsible for bark necrosis in the first of these experiments. Although all trees did not suffer in this way and the necrosis was limited to one sector of the tree only, the incidence of bark death was sufficiently severe to justify a search for preventative measures. Possibly pollarding by stages may provide a solution. So far no evidence has arisen to refute the theories propounded in our article, but more work is required on certain aspects.

An experiment to induce a balanced crown formation at the correct height in clone RRIM 613 is being established in Field 61. Treatments include pollarding, crown budding, and inducing the growth of selected buds by notching. Subsequent pruning of the induced branches is being carried out in order to form a balanced canopy.

GROWTH STUDIES

The Effect of Tapping on the Growth of Hevea

Trees were harvested on two occasions for determination of total dry weight. In January–February, about 6 months after opening for tapping, six trees of clone PR 107 and four of clone RRIM 520 were dug out and sampled. A further round of tree removals was completed in July–August, the end of the first year of tapping, when twelve trees of clone PR 107 and four of RRIM 520 were harvested.

Although the average dry weights had increased by about 25% in the first half and by a further 10–20% in the second half of the first year of tapping, it has, in the main, not been possible to discern differential effects arising from the regimes of tapping and non-tapping. Any differences which may be present are masked by the considerable amount of variation in the total dry weights and fractional

weights such as of canopy, branch wood or trunk. The coefficients of variation for total dry weight for the different experimental groupings range from 10% up to 60%. Future samples will be taken at yearly intervals only.

Some significant differences have appeared in the case of trees of clone PR 107 which were opened for tapping when their girth at standard height was in the range of 15.6–17.5 in. instead of the usual 20 in. Only one post-tapping harvest has been made from these particular trees, however, and at least one more harvest should be completed before conclusions are drawn. At this stage, trees in tapping show an overall growth rate of about 4g/kg/week compared with a rate of about 8g/kg/week by untapped trees. The depression has occurred principally in the weight increments of branch wood.

The generally small differences between the dry weight of tapped and untapped trees is also reflected in the girth increments during the period. In clone RRIM 520, untapped trees have shown a girth increment only 7% greater than tapped ones after twenty-one months, while in clone PR 107 the difference is rather less.

Preparation, drying and weighing of cup-lump samples twice monthly has continued for selected trees of the above two clones. A study has been made of the relationship between yield per tapping over six-monthly periods and two measurements of growth, (a) girth at the beginning or end of these periods and (b) increments in girth during the same intervals. There is a much closer correlation in the former instance than in the latter, correlation coefficients being approximately 0.60 and 0.30 respectively.

Comparison of the Growth of Two Clones from the Time of Budding

The clones under review are RRIM 501 and RRIM 513 growing on adjacent five-acre blocks. Measurements of height, girth at 60 in. from the union and total dry weight have been taken during the year. Changes in the height of the buddings were recorded weekly and continued until, in most of the plants, the main stem had reached its seventh node. This occurred at the end of June for clone RRIM 501 and by the first week of August for the slower growing clone RRIM 513. At the seventh node the average height of buddings of both clones was about twelve feet. Further height measurements would have been difficult and would probably have added little further information since height growth slows down and branching develops after this stage. The average height of a given node was found to be generally a few inches more in clone RRIM 501 than in clone RRIM 513. Further, node height was governed by the size of the stock on which the budding was growing—size of the stock being measured as the girth of the main stem at 12 in. above ground level at the time of budding. With increasing size of stock girths the clonal differences decreased.

The growth in height of *Hevea* is discontinuous—fairly rapid internode elongation is followed by a period of several weeks when the main stem remains at a node. RRIM 501 is a faster growing clone than RRIM 513, and it was of interest to analyse the differences between the growth of the two clones. Observations were made on the average number of weeks occupied at the nodes and during the development of the internodes. It was apparent from the data that the time spent at nodes was similar for both the clones, but time occupied in the elongation of internodes was always at least one week less for the more vigorous RRIM 501 buddings.

Girth measurements at 60 in. from the union were initiated in March, when the majority of buddings were already approximately 100 in. high, and have continued since at approximately monthly intervals. As observed with heights, average girths have been found to vary with the size of the stocks and up to the end of the year such differences have remained very marked, especially in clone RRIM 513. The relative differences are remaining fairly constant; indicative of similar rates of growth. Further calculations are required on the influence of stocks on girth development.

In contrast to the discontinuous manner in which *Hevea* grows in height, growth in girth was found to be continuous (measurements taken weekly). Thus, over a period of sixteen weeks, girth increments remained regular at 0.2 to 0.3 cm per week, irrespective of whether the growth in height was at the stage of a node or elongation of the internode.

An examination was also made of the relationship between the girth of the stock at budding and the subsequent retention of the buddings under normal estate practice, and it was abundantly clear that the buddings retained at field points where two grafts had been successful were predominantly those growing on the larger stocks. For example, in both clones, at 235 such field points, 75% of the retained plants were the larger of the pair.

In June, about nine months after the cutting back of the budded stocks, forty trees (RRIM 501 and 513) were dug out for dry weight determinations. Trees so harvested were representative of different stages of node growth and different categories of stock size at the same node stage.

The distribution of the weight of the whole plant amongst the component parts of root, stock stem, scion stem, and leaves was calculated and presented in the form of graphs. Calculation of regressions of girth and height on dry weights have not yet been completed. At only nine months old, total root is the biggest fraction of the plant weight and for clones RRIM 501 and RRIM 513 respectively is about 1.3 and 1.8 times the total weight of the scion fraction. From some additional trees harvested three months later, the root/scion ratio had fallen to 1.0 (Data from the seven-year-old trees in the 'growth with tapping' investigation (Study I) indicates a much lower ratio of about 0.10 to 0.20).

As is to be expected, dry weights of the scions vary with size of the stocks and differences of up to 20% were recorded. A second set of harvest data (December 1959 – January 1960) is needed before height/girth/dry weight relationships can be critically examined.

Pot Culture Studies

An experiment was undertaken to examine the differences in growth rate, net assimilation rate and rubber content of seedlings of clones AVROS 50 and PB 86 grown in sand culture in the greenhouse. Sampling was done approximately monthly at the completion of each node of growth. Areas of leaves were determined by blue printing them on Ammonax paper followed by weighing of the shadowed portion of the paper. Comparison of these weights with those of known areas of paper enabled leaf areas to be estimated. Growth data have not yet been correlated, but from visual observations differences between the two lines of seedlings should be present. Four plants were grown in each pot bench, but this arrangement led to an excessive amount of mutual shading within pots. In

future studies, only one plant per pot will be grown. The standard method which has been used at the Institute for the determination of the content of rubber hydrocarbon in plant tissues is now under review in the Soils Division and consequently this aspect of the growth investigation has been temporarily suspended.

ECOLOGY

Field Experiments

Ecological studies were continued at R.R.I. Experiment Station. The description of the natural vegetation was again attempted, this time by a change in the usual procedure. Sampling by milliacre quadrats arranged systematically and by selection of ten random points within each milliacre quadrat was tried out. The absence or presence of species under both in milliacre quadrats and random points was noted. The following values were estimated from the data.

1. The composition, i.e. species present
2. Frequency of species
3. Coverage of species
4. Unit plant size of species
5. Density

The value of constants, that is coverage, unit plant size and density, can be used as standards of comparison between the species. By recording values for these estimates for each species at regular intervals in the future, it will be possible to determine trends in the development of the vegetation. Further changes may be necessary in the method used to obtain ideal sampling techniques.

Seed Treatment

Commercial seed testing has been revised after study of the results from recent years. The new procedure simplifies the work to a certain extent and permits a report to be submitted earlier for the more common species.

Various experiments on the germination of leguminous cover crop seeds have been collated in a paper to be published in the *Journal of the Rubber Research Institute of Malaya*, 1960, Volume 16. Soaking the seeds in water, cool or warm, is unsatisfactory in many cases. Scarification with concentrated sulphuric acid or by rotation in a rough-lined drum are good methods. Warm glycerine is effective and experiments are in progress to see if the cheaper crude glycerine may be used to render the method more feasible in practice.

Storage under constant damp conditions depresses the total viability and increases the hard seed fraction in *Calopogonium mucunoides*, *Centrosema pubescens*, *Flemingia congesta* and *Pueraria phaseoloides*.

Scarification mechanically, by cutting and by concentrated sulphuric acid, promotes germination in all four species.

Dry warmth promotes germination in *Pueraria* and to a lesser extent in *Centrosema*. Immersion in warm liquids, especially glycerine, promotes germination. Cool glycerine improves germination to some degree in many cases.

The above phenomena are explicable on the assumption that a hard seed has an impermeable testa and water enters by a path which is hydrostatically controlled.

The treatments tested do not seem to have any marked effect on the viability of the seed but only to effect its germination, in contrast to damp storage.

Only minor responses to Gibrel and Kinetin have been detected. Irradiation with unfiltered infra-red lamps suggests that some radiations may depress germination in three species, but this process is reversed by longer periods of irradiation probably owing to heating effects. *Flemingia* showed a marked response to comparatively brief irradiation.

In their responses to damp storage, scarification and immersion in cool or warm liquids there is considerable agreement between the four species. However, *Flemingia congesta* differs to some extent from the other species in its response to dry warmth, Gibrel and infra-red lamp irradiation.

Herbarium

Three hundred and ten plant specimens of new species were added to the herbarium collection.

580 species of forest trees were identified in Field 23A, R.R.I. Experiment Station, at the request of the Pathological Division in connection with a poisoning experiment. At Bukit Paloh Estate, 2807 trees were identified for the same purpose.

Cover Plant Museum

Establishment of a cover plant museum at R.R.I. Experiment Station in Field 17 was completed with the following species among others: *Calopogonium caeruleum*, *Desmodium gyroides*, *Crotalaria brownei*, *Vigna unguiculata*, *Milletia bussei*, *Dolichos argenteus*, *Sesbania speciosa*.

ADVISORY

Lectures

Research Officers lectured on their own subjects to three Senior Conductors' courses and two Senior Rubber Instructors' courses at the R.R.I. Experiment Station.

Research Officers also gave lectures to the following branches of the Incorporated Society of Planters:

Central Johore Branch.	5 April.	J. M. Ross 'Clones and the Choice of Planting Material'
Negri Sembilan (Central) Branch.	19 April.	P. de Jonge 'Tapping and Yield Stimulation'
North Selangor Branch.	28 June.	P. R. Wycherley 'Factors Influencing the Performance of Rubber Trees'
East Negri Sembilan Branch.	22 July.	P. de Jonge 'Tapping and Yield Stimulation'
Central Selangor Branch.	25 July.	J. M. Ross 'Breeding and Selection of RRIM clones'

Visits

Research Officers made twenty-five advisory visits to estates. The bulk of these were in connection with problems concerning tapping, planting material and yield stimulation.

Clone Inspectors were employed on 150 days in visits to 134 potential seed collection areas and in checking budwood nurseries and smallholdings.

This figure includes nineteen days which the Senior Inspector spent in Sarawak under the auspices of the Department of Agriculture, Kuching. He examined sixteen budwood nurseries from 14 August to 3 September. He also rogued all the State financed budwood nurseries in Pahang from 28 - 30 December 1959.

The total acreage approved for clonal seed collection as at 31 December was 39,792 acres. These areas are on 178 estates.

Distribution of Cover Plant Seeds

Twenty-five pounds of *Flemingia congesta* seed were despatched to nine estates and one and half pounds of *Clitoria rubiginosa* to three estates. Small quantities of seed in short supply such as *Psophocarpus palustris*, *Mimosa invisa* var. *inermis*, *Phaseolus angularis*, *Crotalaria* sp., *Desmodium ovalifolium* and *Centrosema plumierii* were supplied on request to interested local applicants for trial. Small quantities of seed of *Desmodium ovalifolium* (8 oz), *Mimosa invisa* var. *inermis* (4 oz), *Stylosanthes gracilis* (2 oz), *Phaseolus angularis* (2 oz), *Psophocarpus palustris* (2 oz in pod) and *Phaseolus calcaratus* ($\frac{1}{2}$ oz) were supplied to the Tanganyika Sisal Growers' Association, Tanganyika.

Testing of Cover Plant Seeds

Seventy-nine samples of leguminous seeds of commercial origin were tested as under:

NUMBER OF SAMPLES BY TYPE AND ORIGIN

Type	Supplier	User
<i>Calopogonium</i>	10	9
<i>Centrosema</i>	17	13
<i>Pueraria</i>	12	14
<i>Flemingia</i>	3	—
<i>Mimosa invisa</i>	1	—

Identification of Plants and Rubber Seeds

Sixty-four plant specimens received from estates were identified and advisory letters concerning the specimens were sent. Specimens, frequently brought by hand, were also identified.

Thirty-five samples of rubber seeds were received by mail and identified; numerous others were received by hand.

Importation of Cover Crop Seeds

New cover crop seeds of interest were imported from foreign countries as shown below:

IMPORTATION OF COVER CROPS

Source	Species	Quantity
Bureau of Plant Industry, Philippines	<i>Calopogonium caeruleum</i>	0.305 kg
The Tanganyika Sisal Growers' Association, Tanganyika	<i>Milletia bussei</i>	0.4 kg
	<i>Dolichos argenteus</i>	0.2 „
	<i>Glycine javanica</i>	0.2 „
	<i>Leucaena glauca</i>	0.2 „
Messrs A. Gurulingappa & Co., Bangalore, India	<i>Acacia decurrens</i>	1 lb
	<i>Crotalaria grahamianus</i>	1 „
	<i>Indigofera trita</i>	1 „

DESPATCH AND RECEIPT OF PLANTING MATERIAL

Recipient country	Budwood	Rubber seeds	Budded stumps
New Guinea	10 yds	230 non-viable sterilised rubber seeds	—
U.S.A.	18 yds	—	16 budded stumps
Burma	380 yds	—	—
North Borneo	10 yds	—	—
Thailand	93 yds	—	—
Sarawak	—	100 seeds	—

The following material was imported; from Sarawak 500 seeds for identification and from the Rubber Research Institute of Ceylon 52 yards of budwood from ten FX and 42 IAN clones.

Correspondence

The volume of correspondence to the Division remained static; 3,565 letters were received and 4,063 letters despatched. This was due to the routine Advisory work undertaken by the Estates Advisory Service with whom there was excellent co-operation. The analysis of correspondence is shown below:

	Letters received	Letters despatched
1. Buddings — choice of clones	330	246
2. Clonal seedlings — choice of material	8	8
3. Tapping	99	75
4. Yields in commercial tapping	405	723

Botanical Division: Advisory

5. Replanting enquiries	47	30
6. Establishment of seed gardens and selection of areas for seed production	18	13
7. Exchange of planting material	358	283
8. General planting enquiries	226	221
9. Tree poisoning	12	9
10. Yield stimulation	70	54
11. Identification of cover plants and rubber seeds	168	156
12. Germination tests	66	61
13. Identification of clones on estates	215	182
14. Miscellaneous	200	175
15. Experimental planting on estates	1,084	658
16. Correspondence with Manager, Experiment Station	88	260
17. Internal correspondence	207	909
<i>Total</i>	3,565	4,063

Visitors

Fifty-five visitors called upon the Division. They included the following:

Dr W. S. Rogers, East Malling Research Station, England

Professor G. Maxwell Davis, University of Malaya

Monsieur Pitray, French Bank of Commerce and Industry, Paris

Mr J. C. Robertson, Economic Geographer, Department of Geography of
Edinburgh University

Dr D. Archbald, Director of Research, United States Rubber Company

Professor H. H. Boesch, Professor of Economic Geography, University of Zurich

Sir John Medley, Ex-Vice Chancellor of Adelaide University

Dato Osman, Head of the Rural Industrial Development Authority

U Thi, Chief Executive Officer of Burma Rubber Project

Brazil Trade Commission Party

General

There was a gratifying response from a large number of estates which were contacted by circular letter requesting commercial yield records from post-war plantings.

C. W. BROOKSON

Head of Botanical Division

A NOTE ON TIMBER TESTING

During the investigation into the causes and means of prevention of wind damage to high yielding clones, considerable attention has been paid to the question of timber strength. In the standard procedure we have been using, selected trees are felled by saw-cut as near as possible to ground level, and the first seven feet of trunk is taken to the Forest Research Institute for testing. The selected portion of trunk is marked to show a standard height (50 in.) from the stock-scion union, and also the north side of tree.

At the Forest Research Institute, each seven-foot log is sawn through at a distance of 15 cm on either side of the standard height mark, and the resulting 30 cm long section is then split length-wise into 2 cm rods. These rods are cut out from the log in rows from North to South and from East to West (Figure 1) so that positional differences in wood strength within the trunk due to planting system or one-sided exposure may be determined.

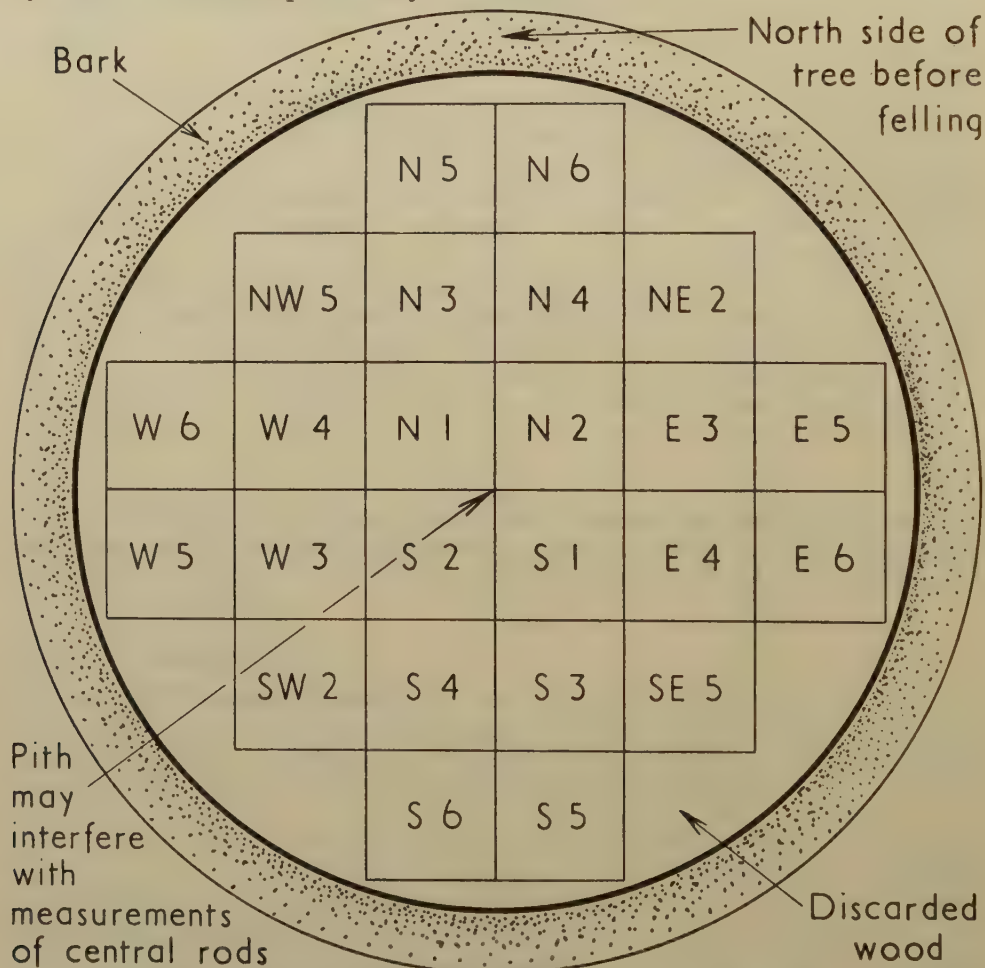


Figure 1. Cross-section of log marked out for timber testing.

Each rod is then placed, in turn, on a machine, in which each end of rod is supported firmly, while a gradually increasing pressure is applied to the middle (Figure 2). The rod, of course, bends in response to this pressure and eventually breaks (Figure 3) at a load which is automatically recorded. This breaking strain may be used to make direct comparisons between the standard rods, and hence between different trees.

In addition to the breaking load of the green wood, specific gravity determinations of green and dry wood are made.

The main series of timber tests made, so far, involved a comparison of the effects of manurial treatments on the wood of RRIM 501, planted in 1951, and brought into tapping in July 1959. Initial results indicated that high potassium as well as high phosphorus lead to a decrease in timber strength. Later measurements have, however, contradicted this result to some extent; in any case, the effects, even if real, are quite small (5 to 6% of mean), and it seems unlikely that tree-breakage can be explained on the basis of the manurial effects on wood so far tested.

A further series of tests have been made, which involve a comparison of the strength of wood samples taken at various heights in the tree, but the results have not yet been analysed. It is also hoped to carry out another series of tests to see if there are clonal differences in respect of wood strength; initial results suggest, however, that these are small.

We are much indebted to the Chief Research Officer, The Forest Research Institute, Kepong, for permission to use the timber-testing apparatus.

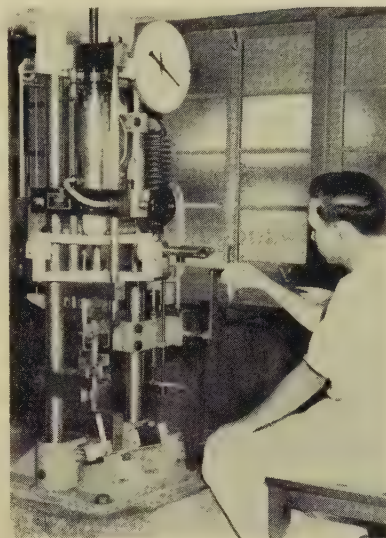


Figure 2. Specimen of rubber wood commencing to bend in the testing machine. The pressure is indicated on the dial and also recorded on a chart.



Figure 3. Specimen of rubber wood breaking in the same machine. The specimen is 30 cm $\times$ 2 cm $\times$ 2 cm.

Pathological Division

Dr A. Newsam, Head of Division, returned from home leave on 14 March. During his absence Mr F. W. Hutchison, Field Research Officer, was Acting Head of Division. Mr Hutchison then went on home leave on 9 April, returning on 17 August. Mr R. N. Hilton, Pathologist, left on home leave on 17 October. Mr B. S. Rao, Assistant Entomologist, was on home leave from 2 March to 5 August. Mr R. A. Fox, Microbiologist, and Mr K. P. John, Assistant Pathologist, were on duty throughout the year.

Mr Hutchison went to Sarawak from 4 to 6 March on an advisory visit. Later, from 6 to 30 September, he made a tour of rubber plantations in North Borneo for the same purpose.

At the end of November Dr Newsam was made primarily responsible, as Chairman of the Programme Committee, for the organisation of the Natural Rubber Research Conference being sponsored by the Institute, to be held in Kuala Lumpur in September 1960.

Mr Hoh Choo Chuan, the Artist who retired in 1958, has been re-employed on a part-time basis to complete the paintings for the projected manual of pests of rubber and cover plants.

The following articles were contributed to *Planters' Bulletin*:

Spray Nozzles	...	...	...	...	...	...	<i>Planters' Bulletin</i>	40
Warm-Blooded Animals	...	...	...	...	...	..	..	41
Checking the Spread of Root Disease	...	...	...	...	...	..	..	43
Approved Fungicides for Mouldy Rot Control	...	...	...	...	...	..	..	44

Three lectures were given to branches of the Incorporated Society of Planters:

'Plant Protection — What to Use and How to Apply It' by Mr Hilton (to the Central Perak Branch, in January);

'Root Disease Control and the Role of Fungicides' by Mr Fox (to the South Johore Branch, in August);

'Recognition of Pests' by Dr Newsam (to the Central Johore Branch, in October).

The book '*Maladies of Hevea in Malaya*', by Mr Hilton, has been on sale since early in the year. Work on the companion volume, dealing with pests, was re-commenced on the return of Mr. Rao. With Mr Hoh Choo Chuan employed part-time, 54 illustrations were completed.

An exhibit illustrating the role of old rubber stumps in spreading root disease was presented by the Division at the annual show of the Malayan Agri-Horticultural Association. The Institute's stall was designed by Mr Hilton.

RESEARCH

ROOT DISEASE

Inoculation Experiments

A comparison of the growth rates of the three major parasites was carried out in an area of peaty sand on the Experiment Station, on trees planted in November 1948 and budded in March–May 1950. The inocula were pieces of naturally

infected root. An earth-sealed observation pit constructed 3 in. on the proximal side of each inoculum was opened each week to observe when growth of the fungus appeared. Three months after the first appearance of rhizomorphs in the observation pit, the roots were excavated to record the extent of distal growth from the centre of the inoculum. Out of ten *Fomes lignosus* infections, seven had made more growth proximally than distally, the mean distances being 31.2 in. and 22.4 in. respectively. Five out of ten *F. noxius* inoculations were successful, the mean growth being 16.0 in. proximally and 6.8 in. distally. These figures suggest that the two species of *Fomes* make faster growth inwards towards the trunk than outwards, from a point of contact on a lateral root. Again on the Experiment Station, 122 four-year-old trees that had been similarly inoculated with *F. lignosus*, in connection with tests of fungicides applied at the collar, were examined after two years. Almost all had recovered or appeared to be recovering. This is not regarded as an effect of the chemicals, which, after one year, had had little effect. Rather it is to be taken as indicating the powers of recovery that trees have, when the source of infection is not large.

The same conclusion emerged from another inoculation experiment in which fifty eight-year-old trees were inoculated with *Fomes lignosus*. One year later, half the inoculated lateral roots were severed at their base, the other half left attached to the tree. All the attached roots were alive at the end of a further year, and even eight of the severed roots. Sixteen of the remaining seventeen severed roots had been rotted by *F. lignosus*.

The long-term field experiment CI-51, comparing methods of root disease control (Report of the Pathological Division for 1951, p.8) has been terminated and the results are being prepared for publication. Total losses in the untreated plots were 75% of those in plots where regular rounds of treatment had been given; but the incidence in the untreated plots is rising while in the treated plots it has fallen to a low level.

Experiment CI-56 compares different methods of poisoning trees and stumps, combined with treatment of the cut stump surface (*Annual Report 1956*, p.41). Assessment is by the numbers of young trees that become infected and of stumps that are identified as sources of infection. Two rounds of inspection and treatment were given—the fifth and sixth. The reduction in disease brought about by the use of a stump surface treatment reported last year persists. A similar beneficial effect of surface treatment has been found in Field 24 of the Experiment Station.

An experiment on susceptibility to root disease of clonal root stocks was laid down at the beginning of the year, using marcots; failure of many of these has made their replacement with rooted clonal cuttings necessary. The intention is to infect the plants with pure culture inocula, which can be standardised.

No effect of root disease on yield has yet been discovered in the 1958 experiment in Field 42N of the Experiment Station, where mature trees have been inoculated with the three major root parasites.

Disease is beginning to appear in the two complementary experiments J-57 and SR-57 (*Annual Report 1957*, p.54) designed to compare the effect of methods of clearing the old stand on root disease incidence in the replantings. Two replications of SR-57, comprising 12 acres on alluvial soil, were taken from the experiment when the land became part of an area being replanted with oil palms. The

remaining five replications are on slightly elevated ground where the soil is more of the inland type. Four rounds of inspection and treatment have been carried out. Losses to date have been less in plots where the old diseased trees were eradicated before replanting. In experiment J-57, three rounds of inspection and treatment have been carried out, at intervals of three months. Although over half of the old trees were diseased, only four cases of root-disease have been discovered in the young stand within the whole 40-acre experiment area.

Fundamental Studies

Isolates of *Fomes lignosus* so far made from rhizomorphs, sporophores, or rotted wood of a number of species of trees fall into three broad groups, based on their growth rate. The fastest growing group consists mainly of isolates from tree species other than *H. brasiliensis*. The group that embraces most of the isolates from rhizomorphs on *Hevea* roots shows least variation. The third and least clearly defined group contains isolates from spore cultures and fructifications.

Strains have been found to differ in their capacity for gas production from the additional carbohydrate incorporated in a modified Jensens medium—sometimes obscuring the penetration patterns that also reflect strain differences. Cultures growing in tubes kept in a moist chamber showed differences in their tendency to form rhizomorphs. Rhizomorph initiation on the solid media is most rapid at lower pH levels, although growth is faster at a higher pH; this accords with previous findings on liquid media.

A method of inducing strains to form sporophores has been developed, consisting of allowing a culture to colonise the base of a wood block, the upper part of the wood being subsequently surrounded with soil; but the method needs further refinement to induce the formation of typical brackets.

Spore Dissemination

Observations have been made at various points in the life cycle of spore-borne root disease. A simple turn-table bearing microscope slides has been constructed and used to follow spore production from detached sporophores of *F. lignosus* held at various humidities and temperatures, for the few hours that it lasts in the laboratory. Sporophores have formed on the stumps of trees killed by root disease, transported to a sheltered place. The times taken for fructifications of all three major root disease fungi to form, and also the duration of sporing, have been recorded. Progress of sporing has been followed by the turn-table trap as used in the laboratory. Volumetric trapping from the air in the vicinity of sporophores has been confined to *Ganoderma pseudoferreum* because of the recognisable spore of this species. Forty-three stumps have been inoculated immediately after felling with fresh spores of root disease fungi. Twelve of these stumps, including two inoculated in late 1958, have been dug out six months after inoculation and isolates made from the wood. No infection was found to have taken place, despite what would appear to be ideal conditions. The anatomy of the cut surface has been studied in relation to spore size, and the internal diameter of the fibres, which compose the majority of the wood elements exposed by felling, is shown to be adequate to admit spores.

Decay of Rubber Wood.

In Field 6 on the Experiment Station, one tree and one stump from each of the eight treatments (*Annual Report 1958*, p.51) were dug out two years after poisoning, and again six months later. Both stumps and trees, and their roots, were in

an advanced stage of decay, a considerable part having been already converted into humus. For disintegration of the root system there is little to choose between tree or stump poisoning with 2,4,5-T; sodium arsenite however, proved better applied to stumps than to the standing trees, although somewhat inferior to 2,4,5-T in both situations.

The fructifications mostly found on stumps and trees at this stage were approximately the same species as those listed on page 52 of the *Annual Report 1958*. *Polyporus (Fomes) scopulosus* showed a preference for 2,4,5-T treated stumps and trees, whereas *Ganoderma applanatum* occurred more on those poisoned with sodium arsenite.

Monthly observations on the fungus flora of stumps poisoned in April 1959 in Field 19 on the Experiment Station were started in August, to record the times at which the fructifications of the different fungi appear.

Tree and Stump Poisoning

Experiment S-58 compared the standard sodium arsenite method of tree and stump poisoning with various methods using 2,4,5-T. There were two concentrations of the latter poison ($2\frac{1}{2}\%$ and 5%) each with and without addition of copper or boron; the effect of position and volume of application was also studied. Each treatment was applied to forty trees or stumps. The trees were felled towards the end of a year. The experiment has been closed, with the examination of the tap-roots and laterals of the last of the stumps one year after treatment. Tree poisoning was found to lead to more rapid root decay than stump poisoning, and 2,4,5-T was followed by more rapid decay than was sodium arsenite. At $2\frac{1}{2}\%$, 2,4,5-T appeared as effective as the recommended 5% , but the size of the trees was rather below the average for coastal areas. Application of $2\frac{1}{2}\%$ 2,4,5-T at ten trees per gallon, spreading the solution around the circumference of the tree to a height of 60 in., gave a more rapid rate of defoliation, and slightly faster decay of the root system, than the standard 15-inch basal application. Spreading the same amount of poison over two 15-inch bands, one above and one below the panel, gave a result no better than the standard method.

The poisoned stumps and stumps of the poisoned trees were examined a year after the treatments were applied. A considerable degree of rot was obtained with both poisons, 2,4,5-T producing a fairly soft and sodium arsenite a fairly hard rot. There was no appreciable difference in the degree of rotting produced by the various 2,4,5-T treatments, nor between $2\frac{1}{2}\%$ and 5% 2,4,5-T.

Experiment S-59 repeated certain of the treatments of S-58, including boron and copper compounds as additives to 2,4,5-T, and compared two commercial sources of 2,4,5-T. Judged from the rate of defoliation, the chemicals from the two sources were equally effective and the additives of no advantage.

Following preliminary trials of poisoning jungle trees in an area of new clearing in Johore, during 1957-8-9, an experiment (BP-60) was started to compare the effectiveness of different poisoning methods, and their subsequent effect in reducing root disease incidence. The jungle trees to be poisoned were identified by the Botanical Division with the help of the Forest Research Institute for which we are most grateful. The girths of the trees also were recorded. Three concentrations ($2\frac{1}{2}\%$, 5% , 10%) of 2,4,5-T were used in two different positions. The progress of defoliation was recorded on three occasions, the last immediately prior to felling, three months after poisoning.

PANEL DISEASES

Two new materials, Seprisan and Antimucin WBR, have been gazetted as additions to the list of fungicides approved for the treatment of mouldy rot, on the basis of tests carried out by the Pathological Division in 1958 and 1959.

BRANCH DISEASES

There has not been sufficient pink disease on the Experiment Station to make experiments on control measures possible.

An *ad hoc* investigation was carried out with a species of *Phomopsis* that had been isolated from a dying lower branch of a four-year-old PR 107 tree. Inoculation did not result in any symptoms of disease.

LEAF DISEASES

Twenty-two reports of secondary leaf fall were received during the year, accompanied by 95 specimens. Mites were more prominent than in 1958, and *Gloeosporium* was the only parasite present on an unusually high proportion of specimens.

DISTRIBUTION OF RECORDS OF SECONDARY LEAF FALL, 1959

Territory	February	March	April	May	Total
Perak	—	—	1	1	2
Selangor	—	2	—	—	2
Negri Sembilan	—	5	3	—	8
Kedah	3	1	—	—	4
Johore and Singapore	—	2	4	—	6
<i>Total</i>	3	10	8	1	22

INCIDENCE OF THE PARASITES ASSOCIATED WITH CASES OF SECONDARY LEAF FALL

Parasite	Percentages of cases in which:					Mean intensity of attack
	February	March	April	May	no other parasite present	
<i>Oidium</i>	15.8	14.8	13.7	1.1	15.8	1.7
<i>Gloeosporium</i>	25.3	7.4	31.6	1.1	27.4	1.7
Mites	—	5.3	25.3	—	6.3	2.7
Thrips	—	—	10.5	—	—	1.7

This is the last year that the figures are being analysed, as secondary leaf fall is now well understood and any change in the situation can be noted by the Institute's staff when touring during the refoliation season. The records of the past twelve years will be summarised.

Power-operated knapsack mist blowers were used in a trial of fungicides for the control of bird's eye spot. Excellent spray deposition—on both surfaces of even the youngest leaflets—was obtained with this method of application. Five fungicides were used: two were formulations of mercurised copper oxychloride in an inert oil; three were water-dispersed materials—phenyl mercury nitrate, ferbam and ziram. After six applications at weekly intervals the ferbam and ziram showed promise, while the phenyl mercury compound stunted the plants. The oil formulations had to be discontinued after the first application because of scorching. The experiment is being continued, for assessment in 1960.

PESTS

Cockchafers

On an estate in Negri Sembilan, control of *Holotrichia bidentata* grubs was attained soonest with 0.1% heptachlor, more slowly with 0.1% aldrin and most slowly with 0.2% chlordane, using four pints per tree of the insecticidal emulsion, poured into dibble holes. Clay loam soil taken from the vicinity of a tree which had been treated with four pints of 0.1% aldrin was found to have lost its toxicity to grubs of *H. bidentata* after two years.

Light traps of three designs were constructed ready for catching adult beetles during the next flying season.

Other Pests

The characteristic damage done to young *Hevea* has been recognised for the following species of mammal: *Rattus raja*, *Rhizomys sumatrensis*, *Callosciurus notatus* and *Tragulus javanicus*. Two species of insect, the grasshopper *Valanga nigricornis* and the caterpillar *Tiracola plagiata*, have been sufficiently severe to warrant control measures.

The caterpillar of a Xyloryctid moth found attacking the bark of young trees, has been identified as *Deloryctis corticivora* Meyrick by the Commonwealth Institute of Entomology, whose assistance with many determinations is gratefully acknowledged.

PESTS AND DISEASES OF COVER CROPS

Further examination of root-knot nematodes associated with *Calopogonium mucunoides* and *Desmodium ovalifolium* has shown that the strains hitherto used for cross-inoculation tests were a mixed population of *Meloidogyne arenaria* and *M. incognita* var. *acrita*. We are indebted to Dr Mary J. Franklin of Rothamsted Experimental Station for identifying these nematodes for us.

ADVISORY

OVERSEAS

The Field Research Officer visited Sarawak from 4 to 6 March, and North Borneo from 6 to 30 September. In Sarawak Mr Hutchison investigated an injury which took the form of vertical splitting at the base of a large number of seedlings

in a nursery planted 18 in. $\times$ 18 in. It was diagnosed as damage caused by weeding operations. In Borneo the three major root diseases were widespread, with *Fomes noxius* rather more common than in Malaya, possibly owing to the greater amount of new planting than replanting there. Pink disease and mouldy rot were of similar prevalence as in Malaya. Bird's eye spot, *Gloeosporium* leaf disease, scale insects and the yellow tea mite were common in nurseries. Legume covers were remarkably free from damage by insect pests.

WITHIN MALAYA

Root disease remained the major topic upon which advice was sought, and many enquiries were received concerning the use of the proprietary material Tillex. Our view is that the chemicals at present available are not to be relied on for prophylactic treatment, though they may be found to have some use in the treatment of diseased trees. From our experience, however, it would appear that the most important part of root disease treatment consists in severing the connection with the source of infection. There was one extensive outbreak of black stripe (on clone PB 86, which is known to be susceptible to the disease) but otherwise few enquiries on diseases of the tapping panel. *Gloeosporium* leaf disease gave rise to more concern than usual, especially in the south of the country. There were few enquiries on pink disease; not it is thought, because the disease was any less common than usual, but because it is now well-known, easily recognised, and has a well-defined treatment.

As a result of advisory correspondence it appears that monkey attack is best dealt with by combining the use of a game scarer with shooting rounds. For cockchafer grub control in young rubber a 1:200 emulsion of Aldrex 2 in water, poured into dibble holes at the rate of 4 pints per tree, has been recommended to estates as a promising method. More cases of the 'suspected bird damage' have been reported, some of which may be due to squirrels. A new pest, the bamboo rat, has been recognised.

Extensive damage to *Pueraria phaseoloides* has been caused in one locality by a slug *Vaginula* sp., and elsewhere by the caterpillars of the Agrotid moth *Mocis undata* F. Other serious outbreaks of cover crop pests have been of the grasshopper *Valanga nigricornis* and the caterpillars of *Tiracola plagiata* and *Lamprosema diemenalis*. Endrin has proved suitable for their control, but a more selective insecticide would be an advantage. Several cases of extensive dieback of cover plants have been recognised as due to the fungus *Rhizoctonia*.

Thirteen thousand packets of *Rhizobium* compost culture were despatched on request to estates and smallholdings.

Summary of Advisory Work and Correspondence

Letters despatched	...	...	...	...	...	499
Specimens examined	...	...	...	...	...	521
Visits to estates and smallholdings	...	...	...	...	...	222
Interviews	...	...	...	...	...	96

A. NEWSAM

Head of Pathological Division

Chemical Division

At the commencement of 1959, the graduate staff of the Division comprised seventeen Division A and seven Division B Research Officers. All the posts were not filled, however, and some remained vacant throughout the year. 1959 was exceptional in that many officers were away from duty on long leave; this was due to the change in length of tour inaugurated in 1957. Under these arrangements a number of officers opted to complete the full length of tour under the old scheme, whereas others accepted the new terms immediately; members of both groups were thus due for leave during the same year. Several officers were also away on study leave. Compared with a normal year having a full complement of staff, it is estimated that graduate staff on duty in Malaya during 1959 amounted to less than 66 per cent of the normal. A member of the British Rubber Producers' Association staff, Dr F. W. Shipley, was seconded to the Rubber Research Institute of Malaya, where he was on duty throughout the year.

Whilst on leave in the United Kingdom, the Head of the Division spent three weeks visiting University Departments at Cambridge, London and Birmingham, industrial laboratories, and the Institut Français du Caoutchouc in Paris, as well as holding discussions with the Director and Staff of the B.R.P.R.A. and attending meetings of the International Rubber Research Board held in London during December. A member of the Division attended the International Rubber Conference held in Washington in November, and presented a paper.

The Division continued to provide liaison between the Committee of Malayan Latex Technologists and the British Standards Institution Sub-Committee RUC/10/7, which deals with specifications for latex testing. Contact was also maintained with the International Standards Organisation and with the Sub-Committees of the American Society for Testing Materials, Committee D-11, which deal with latex and raw rubber. Exchange of views was continued with sister research institutes, with the International Rubber Research Board (I.R.R.B.) and with the International Rubber Development Committee (I.R.D.C.).

Contributions made in 1959 to recognised journals were as follows:

- | | | |
|----------------|--------|--|
| D. H. Taysum. | | The Numbers and Growth Rates of the Bacteria in <i>Hevea</i> Latex, Ammoniated Field Latex and Ammoniated Latex Concentrate. <i>J. appl. Bact.</i> 1959, Vol. 21, No. 2, p. 161. |
| D. H. Taysum. | | A Method for Counting the Total Bacteria in Ammoniated <i>Hevea</i> Latex Systems. <i>J. appl. Bact.</i> 1959, Vol. 22, No. 2, p. 264. |
| G. F. J. Moir. | | Ultracentrifugation and Staining of <i>Hevea</i> Latex. <i>Nature, Lond.</i> 1959, Vol. 184, p. 626. |
| R. S. Gale. | | A Survey of Factors Involved in an Experimental Study of the Drying of Sheet Rubber. <i>J. Rubb. Res. Inst. Malaya.</i> 1959, Vol. 16, p. 38. |

- J. E. Morris and B. C. Sekhar. Recent Developments in the Production and Processing of Natural Rubber in Malaya. *Proc. Int. Rubber Conf., Washington, 1959.*

The following articles were published in *Planters' Bulletin*:

Skim Rubber	<i>Planters' Bulletin</i>	40
American Reaction to TC Rubber	„ „	40
Insulation of Tunnel Driers	„ „	41
Technical Classification of Rubber: Procedures in Common Use	„ „	42
SP Rubbers during 1958	„ „	42
Disposal of Skim Serum	„ „	43
SP Rubbers in the First Half of 1959	„ „	44
SP Rubber in Japan	„ „	45

The following documents were prepared for the I.R.R.B. in connection with Technically Classified Rubber:

Technical Bulletin No. 38, May, 1959.

Technically Classified Rubber, A Summary of activities of IRRB/IRDC. Research and Development Units to December, 1958. January, 1959.

The following internal reports were prepared:

W. A. Southorn.	Chemical Division Report No. 16— The Torsionmeter — An Instrument for the Study of Gels or Foams, etc.
W. A. Southorn.	Chemical Division Report No. 17— A New Recording Instrument for Investigating Time of Coagulation and Related Properties of Latex.
R. S. Gale.	Chemical Division Report No. 18— MG 50—Preliminary Examination of Suitability for Production-Scale Operation of Various Methods of Preparation.
S. Sethu and R. S. Gale.	Chemical Division Report No. 19— Recovery of Ammonia from Skim Latex—Distillation Methods.

The account of the work carried out by the Division which follows is presented in four sections: Fundamental Research, Applied Research, Process Evaluation and Factory Studies, and Advisory and Technical Services. The account is not exhaustive, but covers the principal lines of work carried out and attempts to give in brief the aim of the investigations undertaken and the principal findings, together with their potential or actual value to the plantation industry.

FUNDAMENTAL RESEARCH

BIOCHEMISTRY

The importance of the non-rubber constituents of *Hevea* latex in influencing the technical behaviour of rubber has been recognised for nearly half a century.

It was not until 1949, however, when the first Five Year Programme for co-operative research between the R.R.I.M. and the B.R.P.R.A. was drawn up, that systematic work on these materials was started in Malaya, although isolated substances such as phospholipin and amino-acids had been studied in earlier work.

Biochemical studies in Malaya have dealt with the separation and identification of non-rubber constituents and included the transformations the latter undergo after leaving the tree. The aim of these investigations is to learn more about non-rubber materials so that we can determine the effect they have upon technical properties of both dry rubber and latex concentrate; we can then utilise the non-rubbers to the best advantage in controlling production processes to give uniform products of optimum quality at minimum cost. So far, none of our research has been directed towards the study of rubber biogenesis, which has not been recognised as the concern of the Chemical Division, but rather of those Divisions dealing with the cultivation and metabolism of the rubber tree.

In the course of the last ten years, work on phosphatides, sugars and proteins has been carried out in Malaya, and techniques for the separation and analysis of latex components have been developed, particularly those in which latex is fractionated into different zones by high speed centrifugation at low temperatures, followed by freeze drying. Samples of certain freeze-dried latex fractions have been forwarded to our colleagues at the B.R.P.R.A. for a number of years and have formed the basis of most of the work on latex proteins carried out in Great Britain. The supply from Malaya still continues.

Proteins

During the past year, work has been concentrated on the examination of latex proteins. These comprise a large number of complex components which are thought to play an important part in a number of processes, such as the putrefaction of latex or rubber, preservation of field and concentrated latex, coagulation of latex for sheet and crepe production, drying of rubber and processing of concentrate in foam rubber manufacture.

Earlier work has shown that a number of different protein components occur in the serum of field latex and in the bottom fraction separated by high speed centrifuging. The means first adopted for separating these components was paper electrophoresis, which proved to be a useful but limited technique and was later supplemented by starch gel electrophoresis. A successful effort has been made during the past year to standardise the materials used and also the operating technique, so that reliable and reproducible results can be obtained with this exacting method.

Twenty-two different components have been shown to occur in serum separated by high speed centrifuging (C serum) from seedling and clonal latices. Resolution of some of the bands appearing on the starch gel may not yet be complete and further improvements in technique may be possible. All twenty-two components do not occur in every sample of latex examined, differences between latices having been observed. The significance of these differences remains to be established.

The standardised starch gel technique has also been used to investigate serum obtained by freezing and thawing the bottom fraction. This serum contains fewer protein components than C serum, only ten having been demonstrated so far. The position of the bands on the electropherogram indicates at least one

component common to the two sera; the majority appear not to be identical. Thus, the major band in C serum is anionic whereas that in bottom fraction serum is cationic. An examination of bottom fraction sera obtained from different clones is in hand.

Another technique for separating protein components has also been investigated; this employs columns of ion exchanger such as carboxymethyl cellulose which retain or release protein components according to the pH of the eluent used. As with the starch gel experiments, considerable care has been taken to standardise procedure so that reproducible data can be obtained.

Latex collected from Field 12 seedlings under refrigerated conditions has been used for this work and bottom fraction serum prepared from it. The serum was dialysed against buffer solutions at pH 5.0, using cysteine or potassium cyanide to inhibit polyphenoloxidase activity. Under these controlled conditions it was found possible to separate a component which appeared homogeneous when examined by paper electrophoresis but was resolvable into two major and sometimes three very minor bands by the starch gel technique.

One of these two major components is thought to constitute more than 80% of the total, and can readily be crystallised from aqueous solution to give a mass of needles. Analysis showed a sample to contain a high proportion of sulphur, 5.2%, and in this respect it resembles the component named hevein separated from freeze-dried bottom fraction by our colleagues at B.R.P.R.A. There are slight differences between the two substances however. Thus, the nitrogen content is 16.97 for the R.R.I.M. product and 15.7 for hevein; the ultra-violet spectra are also not identical. These differences may represent different degrees of purity and it is hoped to obtain samples of the B.R.P.R.A. material for comparative examination.

The second of the main components separable at pH 5 from bottom fraction serum occurs in smaller amounts and has been found difficult to separate. The most promising method found so far employs DEAE-cellulose prepared from solka-floc, on which the protein mixture is first absorbed and then eluted by treatment with a series of buffers of different pH, decreasing by stages from 5.5 to 4.5. Attempts are now being made to obtain sufficient quantities of this component for further examination.

MICROBIOLOGY

The fact that latex quickly deteriorates has been known from the outset of the rubber industry and although early workers learned how to alleviate the difficulties by using anticoagulants and preservatives, the basic causes were not systematically examined. With increase in latex concentrate production, difficulties in maintaining uniform supplies developed and complaints by consumers of variability were often heard. In 1951 it was decided that an investigation should be undertaken with a view to obtaining information on the bacterial populations in latex and the spoilage to which they give rise. Laboratory work commenced in 1953. Since that time, we have made a survey of the different bacterial species occurring both in field and in ammoniated latices and have developed ways of reducing the contamination occurring in the field, in the factory and during transport. To check the success of the improved techniques, methods of counting

the number of viable bacteria in latex were developed and used as one of the tests for the quality control of factory production. There is no doubt that the bacterial population of latex concentrate can be reduced to a very low level by giving proper attention to cleanliness in field and factory operations. A marked improvement in the quality of Malayan latex has occurred during the past few years as a result of more careful production methods.

Bacterial Counts

Recently a considerable effort has been made to improve routine counts of viable bacteria in latex and latex concentrates, particularly in regard to accuracy of counting and in developing standard procedures for use under Malayan conditions. The Astell roll-tube technique has been compared with normal plating methods and was found to save both time and medium. This method is now used to supplement normal plating, but with both methods it has been found advisable to run counts in duplicate or triplicate to ensure greater certainty of results.

Most of the above work has dealt with aerobic bacteria. Experiments have now been carried out in Great Britain and Malaya to estimate the number of anaerobes occurring in latex concentrates. Work in Dr Jacobs' laboratory at the Imperial College, London (carried out by Mr Taysum whilst on study leave), showed that whilst the count of aerobic bacteria was often quite low, a considerable number of strict anaerobes (largely *Clostridia* species) could sometimes be found in samples of latex concentrate taken from ships' tanks on arrival at port. Detection of these viable anaerobes is facilitated by the addition of growth factors, such as calcium pantothenate, sodium folate and vitamins B12 and B15 used at 10 parts per million. Work on the anaerobic culture of bacteria from latex samples in Malaya has now been undertaken, and early results support our findings in Great Britain.

Bacterial Contamination of Trees

Another aspect of our study of bacteria has been the discovery that the latex vessels immediately below the tapping cuts of normal healthy trees in regular tapping are contaminated with bacteria. Attempts to reduce the contamination by treating the trees with a bactericide generally resulted in a larger yield of latex with a lower bacterial count. Antibiotics appeared to be particularly effective for this task. The experiments were first carried out on a small number of trees and later a larger scale experiment was carried out on a commercial estate. During the year it became apparent that more statistically planned large scale field trials were needed to establish the effect of anti-bacterial treatments, particularly to determine the magnitude of the increases in yield obtained and to assess the cost. The work was discussed with the Botanical Division and field studies on this project have now been included in their working programme. Meanwhile, the Chemical Division has continued to study the effect of bacterial contamination of tapping cuts upon latex flow, quality, yield, etc. It was demonstrated that twenty healthy untapped trees, Tjir 1 clonal buddings, yielded either sterile or near-sterile latex (less than 10 viable cells per millilitre) when first opened with a sterile tapping knife. As tapping proceeded, using a sterile knife, the intrinsic population in the latex slowly increased; three months after opening the cut a count of one thousand viable bacteria per millilitre of latex

was observed. The number of viable cells present in the latex was markedly increased by previous rainfall, counts between ten and a hundred thousand being recorded, even though the outside of the tree had dried before tapping. In two cases a lysogenic bacteriophage was observed in latex samples some few weeks after tapping commenced; presumably this had entered the latex vessels after the tapping panel had been opened.

Incidental observations showed that the bacterial population of field latex is increased by allowing latex to get warm in the sun during collection and by the practice of placing a leaf on the surface of latex in a bucket to avoid slopping.

A major problem still to be solved is the effect bacteria have on latex; we do not know how the different species attack the complex system of non-rubber substances present. A start on this work has been made, studying the relation between bacterial activity and development of volatile fatty acid (V.F.A.) in latex. Preliminary observations indicate that the major increases in V.F.A. are associated with marked proliferation of viable bacterial cells.

COLLOID CHEMISTRY

Latex is a colloid and many of the problems in handling it arise from this fact. Although much work has been done in temperate countries on the colloid chemistry of preserved latex systems, little has been carried out with fresh latex in the East. A study of latex as a colloidal system was commenced at the Institute in 1954, but only a small effort has been possible to date. Most of our studies have been concerned with the mechanism of converting rubber particles from the disperse form in which they naturally occur to a gel or coagulum, which corresponds with the first stage in manufacturing sheet and crepe rubber. In the course of this work, it became clear that latex is a very complex colloidal system, and that control of coagulation procedures was difficult if not impossible in our present state of knowledge. This became even more obvious when new and cheaper methods of converting latex to dry rubber were investigated, entailing departures from the coagulation procedures normally used. Further confirmation of the complexity of latex was obtained from parallel developments in our work on non-rubber substances in which latex was found to be separable into a number of different fractions, some of which had not previously been recognised.

Microscope Studies

It became apparent early in 1959 that a number of particles occur in latex of which little or nothing is known and that microscope studies employing up-to-date equipment could probably yield valuable new information. Such information might lead to improved methods of coagulating and drying rubber and of centrifuging and preserving latex concentrates.

In order to make use of the best equipment available, work was carried out in the laboratories of two optical instrument manufacturers in Germany by Dr W. A. Southorn whilst on duty leave. Supplies of latex were obtained from small branches of rubber trees, the ends of which were sealed with wax and sent by air from Malaya with the kind co-operation of the Botanical Division. The results were striking and demonstrated the existence in fresh latex of a large

number of complex particles previously unrecognised, showing an internal structure in which active Brownian movement occurred. Within a short time of leaving the tree, internal movement had ceased and disintegration of the particles appeared to be commencing. Examination of the latex, using an electron microscope, confirmed the existence of this internal structure.

Suitable optical equipment has now been assembled in Malaya and the observations confirmed on latex obtained direct from the living tree. It has now been established that complex particles, similar to those mentioned above, form the bulk of the bottom fraction separated from fresh latex by high speed centrifuging. Photographic records of the particles have been obtained (it is believed for the first time). An investigation is in progress on the nature of the smaller particles which form part of the internal structure; the evidence so far favours the view that they are not rubber hydrocarbon.

A systematic study of the zones separable from fresh latex by high speed centrifuging has now been undertaken. Current work is revealing hitherto unsuspected complexities in Frey Wyssling particles, but confirmation of these results by further studies is necessary.

POLYMER CHEMISTRY

An extensive study of the rubber hydrocarbon was one of the first investigations to be undertaken by our colleagues at the B.R.P.R.A. after the establishment of the Welwyn laboratories in 1939. The work was largely carried out in Great Britain but some aspects were studied in Malaya by seconded staff early in the post-war period. It was established that there are differences between the rubber hydrocarbon as it emerges from the tree and as found in commercial usage in consuming countries. In consequence, it has been necessary to carry out work at the R.R.I.M. to study these differences and the processes occurring in the rubber molecule that give rise to them, with a view to turning the knowledge to the advantage of the plantation industry. In the course of this work it was found that many of the chemical reactions of the hydrocarbon of freshly harvested rubber in Malaya differ from those recorded in experiments carried out with commercial rubber in Europe. An example of this is the formation of graft polymers with methyl methacrylate; it was found that this reaction proceeds more easily and more economically in Malaya than in Great Britain.

Graft Polymers

Recent work has shown that further reactivity can be induced in fresh rubber by aeration; the rubber then reacts very readily with methyl methacrylate and can be utilised for the production of graft polymers having shorter methyl methacrylate side chains than those obtained hitherto. A comparison of grafts having long and short side chains has now been made which has demonstrated that short chains confer superior technological properties, such as tension and tear strength, modulus and hardness. At present the advantages do not appear to offset the increase in production cost involved by the new procedure. Since consumers show very little interest in methyl methacrylate graft polymers (MG rubber), no further work will be carried out to cheapen production costs unless an increased demand justifies it.

Reactive Centres in Fresh Rubber

The naturally occurring reactivity of fresh rubber has been the object of detailed study during the past year, particularly in regard to changes in Mooney viscosity to which it gives rise. It was already well known that oxidation of rubber leads to the formation of reactive hydroperoxide groups which modify the viscosity of the rubber hydrocarbon in at least two ways, notably by scission of the hydrocarbon molecule and cross-linking between molecules; the former causing degradation and the latter hardening of the rubber. Recent observations suggest that reactive centres already exist in the polymer molecule when it leaves the tree; these show the characteristics of carbonyl groups and also appear to play a large part in controlling rubber viscosity.

On heating fresh rubber containing no peroxides in the absence of air, particularly under conditions favouring removal of water, cross-linking occurs resulting in a harder rubber. A possible explanation is that a condensation reaction occurs between carbonyl groups and α -methyl groups located in different molecules; attempts are being made to determine the nature of the cross-linking reaction. The hardening which proceeds in the tree as exhibited by the formation of microgel rubber, and that which proceeds in latex concentrate and in dry rubber on storage, are also thought to be of a similar nature.

Further interesting observations have been made in studying the reaction of fresh rubber hydrocarbon with amines. For example, bi-functional amines are found to cause hardening of rubber, which could be explained by cross-links formed by condensation reactions with carbonyl groups in neighbouring molecules. Mono-functional amines and other mono-functional carbonyl reagents which would be expected to react only with one carbonyl group, are found to inhibit completely the hardening which occurs on heating rubber in absence of air, and also that which occurs during shipment and storage of rubber. This accords with the above explanation, since the carbonyl groups would be expected to react with the amine and thus no longer be free to cross-link with methyl groups in neighbouring molecule. These observations may be of considerable value in controlling the changes in plasticity which supplies of commercial rubber undergo during shipment and storage. Patent protection for the process has been sought.

Superior Processing (SP) Rubber

Earlier work has established the improvement in processing properties which can be achieved by the introduction of vulcanised rubber particles into a matrix of raw rubber, and the commercial production of such materials, known as SP rubber, is now well established. The reason for the improved properties was not completely understood and attempts have been made to establish some of the principles underlying the phenomenon with the hope of preparing rubbers with still better processing behaviour. It has now been shown that a number of materials when existing in raw rubber in the form of small particles contribute superior processing characteristics. These materials fall into a general class of polymeric materials of high molecular weight, often capable of exhibiting a fibrous or coiled molecular structure. Examples are proteins, such as casein and gelatin, polyvinyl alcohol, polyvinyl acetal, cellulosic materials, such as wood powder, solka floc, etc., as well as vulcanised rubber. Other polymeric materials such as resins, vinyl

polymers, etc. also confer significant improvements in processing behaviour. It is of interest to record that in general the addition of these substances to latex before coagulation gives better properties than when added to dry rubber on a mixing mill. Patent protection is being sought for these materials and further studies are in hand.

Drying of Coagulum

An investigation on the drying of rubber was commenced in 1951, with a view to obtaining certain basic data which were not then available, but were required for the design of efficient drying houses. The effect of temperature, humidity and rate of air flow upon the rate of water removal from coagulum was studied, a special air drying tunnel being designed and built for the purpose. Unfortunately, the work had to be interrupted and the experimental studies were not completed until the end of 1958; analysis of the large volume of data obtained has now been carried out and some valuable principles established.

Reduction of the water content of coagulum to about 15% is rapid and represents a fairly small proportion of the total drying time, most of which is spent in reducing water content from 15% to dryness. In the latter range, the rate of air flow has a very small effect upon time of drying, and, within the compass of rates normally employed in commercial practice, the actual speed is unimportant as long as the air is maintained at the required humidity and does not become overloaded with water vapour.

The effect of temperature in reducing the drying time from 15% water content to dryness is approximately the same irrespective of the relative humidity of the drying air. It was also found that the effect of thickness of the sheet upon drying time was independent of temperature and relative humidity over a wide range of conditions. These observations have permitted the data obtained to be summarised in the form of a nomograph, setting out the effect of temperature, humidity and sheet thickness upon the time required to dry coagulum from 15 to 0.7 per cent water. It is hoped that these data will be of value in the design and operation of commercial drying houses and the nomograph is being published with instructions for its use.

Certain of the observations made in the course of these studies have already been applied to practical problems and some are already being used in commercial driers. This aspect of the work is discussed in more detail under the section headed Process Evaluation and Factory Studies.

APPLIED RESEARCH

LATEX TECHNOLOGY

Work on latex technology may broadly be divided into two main fields, the first being the technology of latex concentrate production and shipment, the second the technology of latex concentrates as used in consuming industries. Our work is concerned mainly with the former field, the production of latex concentrate, but consumer practice and requirements are also taken into account. During the past

few years we have had to study some aspects of 'consumption' technology in order to be able to advise the industry on methods of producing latex having the properties required by the user. The position is not static, since consumers' needs are continually changing as more economic methods of manufacture are introduced. Future studies must obviously keep up to date with developments in the use of both natural and synthetic latices, particularly in regard to mixtures of the two which are now commonly employed.

One of the main problems in latex concentrate production is satisfactory preservation, which means not only prevention of bacterial contamination and degradation, but also the satisfactory maturation of the concentrate to give the required properties, the retention of these properties without change over as long a period as possible, compatibility with the manufacturers' compounding and processing techniques and the absence of injurious chemicals both in the finished product and in effluents discharged from factories.

Preservation

Recent work on preservation has dealt largely with low ammonia systems, which now represent a substantial proportion of the total Malayan latex output. A wide variety of bactericides, bacterial enzyme inhibitors, sequestering agents and stabilising agents have been tried, hundreds of systems having been systematically examined. The more promising of the recent new systems include the following reagents: 8-hydroxyquinoline, certain chlorophenols, *N:N'*-dimethyl-S-carbethoxy dithiocarbamate, cumene hydroperoxide and the zinc salt of mercaptobenzthiazole. These compounds are usually satisfactory when used with 0.2% ammonia, but are far more effective if employed with 0.2% ammonia together with boric acid, zinc oxide or sodium pentachlorophenate. Combinations of zinc oxide and boric acid with low ammonia have also been found effective. By combining three agents in this way, excellent preservation can often be achieved with a very low level of additives. The work involved in evaluating these systems is considerable and final conclusions as to the most satisfactory systems have not yet been drawn. Patent protection has been applied for in a number of instances.

Several organo-metallic compounds of tin and certain fluorophenols have also been examined. The tin compounds were not suitable as preservatives but certain of the fluorophenols gave satisfactory results. Since the latter compounds are expensive and not outstandingly good, no further investigation is proposed at present.

With the development of new clonal planting material, changes must be expected in the field latex from which concentrate is prepared. It is therefore necessary to examine latices from new clones as they come into bearing, to determine whether they are suitable for concentrate production. Recent examinations of a wide range of clones from different estates confirm earlier reports that the new latices have a broad range of properties; thus the mechanical stability of concentrates from certain clones remains very low even after some months' maturation, whilst that of others appears considerably higher than average. Compilation of reliable information on this point will take some time, but certain clones are now regarded as likely to yield abnormal latex concentrates and should be used with caution for this purpose.

Effect of Manuring on Latex Properties

The influence of manurial treatment upon latex concentrate properties has often been in question, but insufficient information has been available to establish a complete picture. Attempts to obtain further data are now being made, trials on one estate having started in 1958 and on another in 1959, both in co-operation with the Soils Division.

Limited data are available from the first estate trial and indicate an increase in nitrogen content following application of nitrogen, and of potassium following both potassium and nitrogen treatments. These increases were significant in about half of the ten collections analysed during the eighteen months since treatment was started.

In respect of the properties of the concentrate prepared with these latices, seasonal changes were far more marked than effects of manuring. There are indications, however, of a small increase in mechanical stability (ASTM) after treatment with K, P, KP and NKP, and a small decrease following N. It should be noted that these conclusions are tentative and moreover are based only on one trial.

Foam Rubber

Investigations on the consumption side have been confined largely to work on foam rubber, the aim being to compare different types of low ammonia concentrates for foam production. The tests were carried out under carefully controlled conditions of temperature and humidity, since the latter are known to have marked effects upon foam rubber properties.

The concentrates tested comprised normal ammoniated latex, and low ammonia types containing respectively, boric acid, sodium pentachlorophenate, zinc diethyl dithiocarbamate and Actamer (2,2' thio-bis-(4,6 dichlorophenol)). The concentrates were all prepared from the same bulk, so that a strict comparison of the systems employed could be made. They were tested in a modern formulation with a fairly high filler loading. Completely satisfactory products were obtained from all the concentrates, but the formulation used had to be adjusted for both boric acid and Actamer latices, the changes required being slight. Small differences in properties of the foams were observed and have been confirmed by parallel tests carried out on the same latices at the B.R.P.R.A. Boric acid latex gave properties most nearly resembling those obtained with normal ammoniated concentrate. The other low ammonia latices gave higher volume shrinkage and higher compression modulus at the same density.

In the course of this work some interesting observations have been made on the testing of foam rubber in a state of compression, which indicate that the loss of compression modulus of natural rubber foams after repeated flexing is not necessarily permanent and may be largely restored by appropriate treatment. This observation makes a useful contribution to our understanding of foam rubber structure and may lead to the development of methods for improving the compression strength of natural rubber foams.

RUBBER TECHNOLOGY

Although natural rubber is marketed as International Types graded by visual inspection, its value to the consumer is judged by its behaviour when used in his

factory. Technological testing of dry rubber thus forms an important part of our work since it provides the basis of controlling the quality of production according to consumers' needs.

With established forms of raw rubber, continual checks on quality are required. Periodical surveys on a larger scale also have to be carried out; for example, in connection with the examination of new planting material, consumers' complaints and the development of new or modified test specifications proposed by standards organisations.

Much of the work on dry rubber technology concerns modified or new products, which after preparation in the laboratory have to undergo preliminary assessment for possible value to consumer industries. With new products too, a new technology comprising test procedures and compounding techniques sometimes has to be worked out. When such a new product is being developed commercially, care must be taken to ensure control of factory production, particularly until a discriminating market has been established. Some of this work is carried out in co-operation with our sister institute, the B.R.P.R.A., since each institute can best cope with the problems arising within its own territory.

Problems such as the development of new uses for existing forms of rubber and new techniques of compounding to give enhanced properties are not normally dealt with at the R.R.I.M., since they are better handled in Great Britain by the B.R.P.R.A. where intimate contact with the consuming industry can readily be made. Work in Malaya derives largely from production problems and the attempt to supply the consumer with the material he needs.

Test Procedures

During 1959, time has been devoted to a revision of our laboratory test procedures and errors of testing; cross checks with other laboratories have been undertaken. Work on lower grade rubbers has been started in co-operation with the B.R.P.R.A. with a view to establishing a clearer picture of their properties and variability. This study is also providing an opportunity for comparing standard test procedures carried out in the East and in Great Britain.

The study of superior processing rubbers (SP rubbers) has occupied a large proportion of our time, not only in testing new and cheaper experimental types, but also in standardising test procedures, and in developing a newer and more rapid test, the mill shrinkage test, which is required to cope with the numerous commercial samples submitted for the quality control of production by estates. Control charts have now been set up for each estate producing SP rubbers and have reduced the labour of testing involved, as well as giving valuable indications of trends in production which readily permit adjustments in factory processes when necessary.

Other investigations have compared the Williams and Wallace Plastimeters for use with raw rubbers. Preliminary findings, which have to be confirmed, indicate that better discrimination between rubbers is given by the Wallace instrument, which also permits much more rapid testing. It was observed that the Williams discrimination factor for raw rubber increased with time of compression employed, whereas for aged samples, the time of compression to give optimum discrimination varied with the degree of ageing.

Rapid Strain Test

In the course of routine testing of rubber for Technical Classification, a rapid test procedure is often employed so that information can be forwarded to estates and packing houses as quickly as possible. Data obtained by this method are related to those obtained by the internationally accepted test procedure and conversion curves to relate the two sets of data have been established. It has now been observed that rubbers treated with Fixanol, with the object of changing the classification from one class to another, do not conform to the conversion curve.

A more thorough assessment of the conversion curve for normal rubber has now been made and it has been shown that in the range of strain values from 50 to 110, which covers the majority of the rubbers tested, the relation may be represented by a quadratic equation.

Further work on the relation between vulcanising characteristics and chemical analysis of rubber sheet has confirmed earlier findings that tension strain shows a strong correlation with acid and base content determined by titration methods.

Red Clay Masterbatch

Interest has been shown in Malaya in the red clay masterbatch (100 TL) first produced in Indo-China by the Institut des Recherches sur le Caoutchouc au Vietnam. Samples requested from I.R.C.V. have now been received and examined. Our tests showed the materials to possess better properties than most clay stocks. In general, however, the level of properties was not quite so high as that given by compounds with MPC black, particularly in respect of tension and tear strength and resilience. The material does not appear to offer marked advantages over those obtainable from known compounding techniques.

PROCESS EVALUATION AND FACTORY STUDIES

Work under this heading concerns the study and development of new or improved methods, equipment and processes for use by the plantation industry in the manufacture of both current and new products. Investigations arise in a number of ways, the more common being the emergence of new facts from research, the occurrence of new industrial developments providing better machinery and materials, and requests for assistance from the industry. Most of the investigations are carried out on pilot or full scale plants and are coupled with design and costing studies. The objectives of these studies are to improve efficiency of factory operations, to lower production costs, and in some cases to develop new materials with improved technological characteristics offering the possibility of a profitable enterprise for producers.

Treatment of Factory Waste

Until recent years, few problems arose in connection with the disposal of factory wastes and in the past little work was done to determine the optimum procedure for Malayan conditions. By 1957, however, it was noted that some factories were experiencing difficulties and we consequently examined different methods of dealing with the main types of effluent. These consist largely of the acid serum

normally discharged from sheet and crepe factories, the acid serum containing ammonium salts arising in latex concentrate factories when skim rubber is recovered from latex skim, and the wash water from remilling factories.

Several aspects of the problem were considered, including alternative methods of recovering rubber from latex skim and the possibility of recovering other useful materials from the wastes in the course of their disposal. Three main lines of study have emerged from this survey: (i) effluent disposal; (ii) recovery of ammonia and rubber from skim; (iii) use of skim serum as fertiliser. The possibility of putting factory waste to other uses, such as the recovery of quebrachitol or protein, utilisation of serum for culturing micro-organisms, have not been ignored, but are regarded as of less immediate importance to the industry and so are not being actively pursued at present.

Effluent disposal. Of the two main methods of dealing with factory effluent, aerobic treatment on a trickling filter was preferred to anaerobic digestion in closed systems, largely on the grounds of easier control. A small full-scale plant was built at Sungei Buloh to deal with the factory waste; this has been operated experimentally since the end of 1958, and has demonstrated that a trickling filter can be used successfully under local conditions for treatment of rubber and latex factory wastes.

Treatment in the plant is carried out in two successive stages. In the primary stage the effluent is first filtered and then treated in batches with flocculating agents such as ferric chloride followed by lime, allowed to settle, and the supernatant liquor run off. In the second stage, the liquor is continuously fed to a trickling filter bed, whence it passes through a humus tank, where excess solids emerging from the filter bed are allowed to settle to a sludge. The aqueous effluent is then sufficiently clean for discharge to drains, streams and so on. Sludges resulting from the purification are dried on sand beds to sweet smelling solids which can be spread on the land.

Substantial reduction in the B.O.D. (biological oxygen demand) of Malayan factory wastes can be obtained by this means, even though the filter requires to be operated at much higher organic loading rates than normally recommended for temperate climates. Hydraulic loading rates are correspondingly low for discharges from Malayan factories, and for maximum efficiency it appears desirable to employ recirculation of the effluent through the filter.

Although the B.O.D. of effluent from sheet and crepe factories is higher than that from latex concentrate manufacture, the presence of ammonium sulphate in the latter makes it more difficult to handle and is likely to reduce the efficiency of a trickling filter plant. Steps to remove the ammonium sulphate by chemical means were examined. The most successful was the use of bleaching powder, but the large quantities required made the method costly.

Since large amounts of sulphuric acid are required to neutralise the ammonia in latex skim before rubber can be coagulated, it is apparent that removal of ammonia before coagulation would not only save acid, but also prevent the occurrence of ammonium sulphate in the final effluent. Parallel studies were therefore carried out on the possibility of removing and recovering ammonia from skim latex.

Recovery of ammonia and rubber from skim. The possibility of recovering ammonia from skim is attractive for several reasons. First, the recovered ammonia

can be fed back to the factory, so reducing total consumption; second, there is a marked saving of the acid consumed in coagulating the skim rubber; third, the degree of pollution of the effluent is reduced; fourth, all requirements can be met by a compact plant; finally, the whole operation can take place on the site of the latex factory.

Our first step in this project has been to study the economic aspect. A review of possible methods of ammonia recovery shows that the most suitable method is likely to be steam stripping of ammonia direct from the latex skim. This would yield a dilute solution of ammonia which could be concentrated to a 90% solution under pressure, in a separate plant. From a theoretical study, it has been concluded that estates using 0.5% ammonia in field latex when centrifuging would benefit financially by operating an ammonia recovery plant, and those employing 0.3% ammonia could increase the quantity to 0.5% without incurring additional cost.

Practical trials in the laboratory have demonstrated the feasibility of the process and have shown a marked improvement in the ease of coagulation of latex skim after ammonia removal. It has been decided to carry the investigation a stage further by setting up a small scale ammonia stripping plant to learn what practical difficulties are likely to be incurred in operating the first stage of the process and to obtain more precise information about the cost involved.

Use of skim serum as fertiliser. The potential value of skim serum and other factory wastes as fertilisers has been recognised for many years and some estates have made it a regular practice to utilise them in this way. Experimental work was carried out during 1958 investigating the possibility of concentrating or drying effluents in order to avoid handling large bulks of liquid and to reduce costs; it was found to be uneconomic since the cost of drying exceeded the value of the fertiliser obtained. The question of utilising the unmodified effluent was then studied and it was calculated that a latex concentrate factory should be able to supply nitrogenous fertiliser to about 7% of the trees supplying the factory's latex. This will give an economic return provided the factory is adjacent to the rubber plantation. Recommendations to this effect were published during the year and it is gratifying to record that several estates have now adopted the process.

Methyl Methacrylate Graft Rubbers (MG Rubber)

Methyl methacrylate graft rubbers were first developed by the B.R.P.R.A., a *Technical Bulletin* describing them being issued in 1954. There was only a small demand from consumers in Great Britain, and to meet this the graft was prepared by a commercial company using imported latex concentrate as a source of rubber. During the past year or two, interest has been shown in these materials by Australian manufacturers. The question of providing supplies from Malaya then arose and work was undertaken to establish conditions for satisfactory large scale production. A process has been developed which utilises field latex as the starting point and thus lowers the production cost. Difficulties were experienced with coagulation, and the method finally worked out is to use hot dilute formic acid, giving a crumbly coagulum which can be milled to a crepe and hung to dry.

The process has to be modified a little according to the proportion of rubber to methyl methacrylate required. The material most in demand is MG 49 (rubber

51%, methyl methacrylate 49%) but MG 30 is sometimes required. Commercial development of these materials does not appear very promising and no further work on the project is proposed at present.

Design of Drying Houses

A number of valuable observations concerning the drying of rubber coagulum were made incidentally during laboratory work on drying rates. The effects of intensity of machining are particularly relevant. Greater pressure during machining gives a thin sheet of lower water content so that drying is more rapid and less fuel is consumed. Added to this, greater intensity of machining encourages syneresis and sheets will drip to a still lower water content, leaving less water in the sheet to be evaporated. This fact recalls the importance of good drainage in driers, which is emphasised by the observation that increased humidity reduces the drying rate.

A further advantage of heavier machining is that thinner sheet is less susceptible to blister and bubble formation. It has also been shown that blister formation is reduced by high humidity; our published information on this subject is already being utilised in commercial drying.

The above observations together with the basic data now accumulated, are being used in design studies for a more efficient drier, incorporating two stages of drying, one at high, and the other at low humidity.

Bubbles in Sheet

The work of recent years has shown the effectiveness of a large number of bactericides, antibiotics, sequestering agents and other materials in preserving lightly ammoniated latex. It appears possible that some of these substances may prove useful for the preservation of field latex, both during collection and transport and on standing in the factory; a programme of investigation has therefore been planned. A preliminary survey of a number of reagents has already been made in which the chemicals were added to untreated field latex on receipt at the factory, counts of viable bacteria being made at intervals. Part of the latex was coagulated and made into sheet; the serum was examined for bacteria and the sheet inspected for bubble formation. The result of this preliminary work is surprising, since none of the preservatives used proved as effective as formaldehyde in avoiding 'fermentation' bubbles. Our observations have led to two lines of thought: (i) the formation of 'fermentation' bubbles in sheet and the precoagulation of latex, although often associated, may constitute two separate problems; (ii) the occurrence of 'fermentation' bubbles in sheet may be closely related to the number of viable bacteria in the serum. The work also confirmed an observation already well known, that bubble formation may be inhibited by lowering the pH at which coagulation occurs. Further work is planned.

Superior Processing Rubbers

Practical developments during the year in SP rubbers have centred around the production of a satisfactory masterbatch or concentrate, which can be mixed in relatively small amounts with any grade or mixture of rubber, natural or synthetic, to confer better processing characteristics.

The highest concentrate which appeared feasible on the basis of laboratory tests was one containing 90 parts of vulcanised and 10 parts of raw rubber, which was known as SP 90. On shipping this material overseas, difficulties were experienced by consumers in blending it with rubber stocks; this was found to be largely due to changes occurring after preparation. SP 90 masterbatch was therefore abandoned, and a lower level of concentration (80:20) tried; this has proved satisfactory and is now available in commercial quantities under the name PA 80 rubber.

Production on a commercial scale has encountered several problems, the most troublesome being creping and drying. On milling the wet coagulum, a broken crumb is obtained, not a crepe. If this crumb is first dried and then remilled dry, a good thin crepe is readily obtained. The first shipments of PA 80 were prepared in this way.

Larger scale production on these lines, however, showed overheating of the creping mills when the dry crumb was continuously handled; the process also had the disadvantage of double handling and milling which increased cost of production.

Attempts to produce a thin crepe by heavy machining before drying were not completely successful and the process now adopted is to dry the crumb in trays, followed by compression to a solid block in a bale press. The blocks are packed in polythene-lined multi-wall paper bags and have been found to travel very well. The process now awaits development by commercial concerns.

Production of Special Rubbers

The production of special rubbers at the Experiment Station Factory during the year is given below:

PRODUCTION OF SPECIAL RUBBERS AT THE R.R.I.E.S. FACTORY

Type	Produced, tons	Shipped, tons
SP RSS	30.8	21.6
SP brown crepe	22.4	34.6
SP 90	0.8	0.9
PA 80	3.1	2.9
MG 49	0.4	0.8
MG 30	0.1	0.1

Production of SP sheet by the factory stopped early in 1958, but was resumed in September 1959 to help overcome the shortage of commercial supplies then prevailing. SP brown crepe production was started on a commercial scale in the factory at the end of 1958, and was stopped when local producers undertook its manufacture. Production at the Experiment Station factory had to be resumed later in the year when demands for SP brown crepe exceeded the supply.

Double B Smokehouse

Drawings for a new Double B smokehouse at the Experiment Station have been completed. The design includes a modified steel arch furnace, which it is hoped will overcome difficulties with warping experienced in the current model, caused by unequal expansion of different parts of the furnace. The floor of the smoke-

house is to be one and a half feet above ground level, and will be approached by ramps. One of the two tunnels will be built in the customary way, the other will have panels of different insulating materials on walls and roof. This will provide data on the mechanical behaviour of the insulating materials tried and will enable us to assess any operational advantages, such as reduced fuel consumption or greater temperature stability, arising from their use.

It is doubtful whether the cost of insulation is warranted for smokehouses running on firewood. When the latter is in short supply and conversion to oil firing becomes necessary, it is probable that insulation leads to definite saving. Trials with the new Double B drier should clarify the situation.

ADVISORY AND TECHNICAL SERVICES

The Advisory Service operated by the Chemical Division is concerned chiefly with technical problems arising in latex collection, factory processes, shipping and marketing. Enquiries may be divided into three major groups of approximately equal size, concerned respectively with sheet and crepe production, latex concentrate, and special rubbers.

Most of the work arises from written or telephone enquiries and visits are undertaken only on request or following correspondence when matters cannot be settled by writing. A large volume of testing work is also undertaken on the producers' behalf; much of this work is carried out free but payment of a standard fee is requested when routine tests are required. During 1959 there has been an increase of about fifty per cent in the number of tests requested compared with the previous year.

A new aspect of our advisory work has opened up since the formation, late in 1958, of a Technical Service to manufacturers in Great Britain operated by the B.R.P.R.A. This has resulted in problems and enquiries from manufacturers being referred back to us and has enabled us to assist producers in solving them. Some of the complaints have been found unjustified, but in cases where real problems exist, contact with both producers and consumer has often resulted in improved production and a more satisfactory service to the consumer.

This liaison aspect of our work is particularly evident, where consumers are anxious to acquire new or improved materials. In such instances we have been able to assist in establishing new production processes and new markets for natural rubber products; partially purified crepe (PP crepe) and the series of SP rubbers are examples of such new processes, which are now proving profitable to Malayan producers. This is very uphill work, since no mechanism for the large scale development of new products exists in the industry and we find private concerns are naturally reluctant to undertake the risks involved in embarking upon the production of new materials when a ready market already exists for their established products.

There is no doubt, however, that by marketing new products designed to fulfil consumers' demands better than existing ones, the plantation industry is establishing itself more firmly and showing that it can adjust itself to meet the demands of modern manufacturing industries.

Office Records

Office records for 1959 show the following figures which indicate an increase in written advisory enquiries by about ten per cent over the previous year:

	<i>Letters received</i>		<i>Letters despatched</i>	
	<i>1958</i>	<i>1959</i>	<i>1958</i>	<i>1959</i>
Sheet rubber production	318	243	368	291
Crepe rubber production	271	421	284	432
Latex production	778	752	1,154	1,139
Other processes	570	751	715	1,034
Technical Classification of rubber	1,537	1,288	830	723
Research and other matters	661	811	806	1,128
	<u>4,135</u>	<u>4,266</u>	<u>4,157</u>	<u>4,747</u>

<i>Visits :</i>	<i>1958</i>	<i>1959</i>
Advisory	236	260
Experiment Station	516	462
Research and other matters	73	54
<i>Interviews</i>	<i>443</i>	<i>417</i>
<i>Lectures to Planters' Associations</i>	<i>1</i>	<i>3</i>

Samples examined

Latex hydrometers	62	47
Customs' samples for d.r.c.	590	878
Latex	1,053	1,041
Coagulants	3	1
Defects in sheet and crepe	361	803
Cyclised rubber	119	83
SP rubber	938	1,874
Others	259	352
	<u>3,385</u>	<u>5,079</u>

TCR	22,235	22,173
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Sheet and Crepe Production

The effect of replanting with higher yielding material is now beginning to show in increased outputs from many estates. In consequence, advice has been sought on increasing the throughput of drying houses by reducing drying time and on plans for enlarging factories and smokehouses.

Increase in output has been accompanied by an increase in variability of the product, possibly due to new areas of young plantings coming into bearing; the use of new tapping systems has probably been another factor which has increased variability. These problems have been noted particularly on those estates taking part in the scheme for Technical Classification, for which we keep charts showing changes in technical properties of the rubber produced. Modifications in manufacturing processes have been recommended to cope with these problems, which have been satisfactorily surmounted in almost all cases. A number of estates have had trouble with bubbles in sheet, leading to lower grading of their product. This has been overcome by using suitable anticoagulants, by adding more acid for coagulation and by coagulating at a lower d.r.c., followed by machining to thin sheet, which reduces the incidence of both bubbles and wet patches.

Many estates have adopted oil-heated air-circulating drying tunnels, and are well satisfied with their performance. They are, of course, readily adapted to the production of air-dried sheet, for which there was a slightly increased demand towards the end of the year. A few producers have converted drying sheds for brown crepe from natural air drying to this system and obtained satisfactory results with a much larger throughput.

Little interest was shown in pale crepe during the first half of the year, largely because the premium obtainable over RSS 1 was so small as to make production unattractive. During the last few months of the year, however, the situation improved.

A few complaints were received concerning discolouration of pale crepe on storage. There is some evidence that this may be associated with amines naturally occurring in latex, and the use of a proportion of oxalic acid in the coagulant has been found to have beneficial effects in a number of cases. Apart from this, the manufacture of good white crepe appeared to present few problems; considerable quantities of the R.R.I. bleaching agent, Emulsion A Concentrate, were used.

Latex Concentrate

The output of latex concentrate from Malaya was greater during 1959 than in the previous year. The standard of cleanliness maintained in most Malayan factories was high and few complaints of unsatisfactory quality have been received from consumers. The number of enquiries on latex problems received from producers was some fifty per cent greater than in 1958.

Interest is still shown in low ammonia latices, the output of which has increased slightly. The production of one of these, boric acid latex, has been more than doubled, being 606,900 gallons in 1958 and over 1,500,000 gallons in 1959. Ten companies are currently producing this type of low ammonia latex.

Special Types of Rubber

A number of special rubbers based upon processes developed at the Institute are now being produced in Malaya in commercial quantities.

The Division has continued to advise on factory processes and to carry out quality control checks of the production. The accompanying table shows the types and quantities of rubbers produced.

Chemical Division: Advisory and Technical Services

ESTIMATED COMMERCIAL PRODUCTION AND SHIPMENTS OF SPECIAL RUBBERS BASED ON R.R.I.M. PROCESSES, 1959, IN TONS

Type	Production	Shipments
SP RSS 1	1,857.0	1,720.0
SP crepe	260.0	328.0
SP ADS	65.0	60.0
SP brown crepe	199.0	208.0
PA 80	3.4	2.9
Cyclised rubber	60.0	60.0
Partially purified crepe	85.2	85.2

During the year a considerable part of our efforts were spent in developing SP rubber production, particularly in assisting new estates to undertake manufacture and in introducing the new processes for making SP brown crepe. At present eight estates, as well as our Experiment Station, are in production; the total amount of SP rubber shipped during the year was 2,316 tons, more than double the 1958 figure.

Commercial production of SP rubbers was found to be straightforward and problems arose only when insufficient attention was paid to vulcanising field latex, which forms part of the process. The difficulties arose from poor dispersion of the vulcanising ingredients due to inadequate ball milling and the use of unstable and even putrefied field latex, both of which can readily be avoided.

Technical Classification

The production of Technically Classified (TC) Rubber has remained at much the same level during 1959, the total output from estates being estimated at 28,473 tons as compared with 28,785 tons for 1958. Production from packing houses was small, being 407 tons as compared with 834 tons for the previous year.

The number of estates co-operating fell during the year from 92 to 70; 28 estates withdrew and 6 more estates joined the scheme. The overall effect has been an increase in efficiency of the scheme since the same amount of rubber has been classified from fewer estates. The main reason for estates withdrawing was a policy decision to sell latex instead of sheet. Two estates withdrew on the grounds of lack of demand for TC rubber.

Details of estimated production for estates in the Federation of Malaya and British North Borneo are given below:

ESTIMATED OUTPUT IN TONS OF RUBBER FROM ESTATES USING R.R.I.M.
FACILITIES FOR TECHNICAL TESTING†

Type of rubber	Technical Classification			
	Red Circle	Yellow Circle	Blue Circle	Total
Int. No. 1 RSS	460.0	19,199.0	5,481.0	25,140.0
Int. No. 2 RSS	16.0	334.0	3.0	353.0
Int. No. 3 RSS	4.0	81.0	—	85.0
Int. No. 4 RSS	—	117.0	—	117.0
Clippings	5.0	88.0	—	93.0
Pale crepe	282.0	—	—	282.0
Brown crepe	—	108.0	195.0	303.0
ADS	768.2	1,193.4	138.0	2,099.6
<i>Total</i>	1,535.2	21,120.4	5,817.0	28,472.6

† Including production from British North Borneo and from Socfin Company.

Five different packing houses have requested technical classification, the actual amounts of rubber involved being as follows:

RUBBER FROM PACKING HOUSES CLASSIFIED AT THE R.R.I.M., LONG TONS

Type of rubber	Technical Classification			
	Red Circle	Yellow Circle	Blue Circle	Total
Int. No. 1 RSS	2.0	191.0	43.8	236.8
Int. No. 3 RSS	Nil	Nil	170.0	170.0
<i>Total</i>	2.0	191.0	213.8	406.8

The demand for TC rubber continues; recent enquiries for supplies originated in Australia, Spain and the U.S.A.

The Division has continued to act as technical co-ordinator for the international aspects of the TC Scheme, under the auspices of the International Rubber Research Board. Laboratory cross-checks have been carried out with TC test stations in other producing territories, and reports on international TC activities prepared and submitted to the I.R.R.B.

Chemical Division: Advisory and Technical Services

Technical Service to Malayan Manufacturers

For a number of years we have received enquiries from local consumers of rubber and latex seeking guidance in their use. These enquiries usually concern problems arising in the manufacture of rubber goods and often entail testing or experimental work in the technological laboratories. Many of the enquiries have been dealt with in co-operation with the local office of the N.R.D.B. Although assistance has been given wherever possible, there has been no recognised official service provided by the R.R.I.M. for local consumers of rubber. Towards the close of the year, however, the anomalous situation was recognised and permission given to inaugurate an official Technical Service. At present the service provided continues to be operated by the rubber and latex technologists working in the Division. Should the volume of work expand, it may be necessary to recruit new staff to deal with it. Co-operation is being maintained with the technical service operated by the B.R.P.R.A. in Great Britain and the U.S.A.

The enquiries dealt with during 1959 are analysed below:

TECHNICAL SERVICE TO LOCAL RUBBER CONSUMERS

Organisation	Number of enquiries involving:	
	Information and advice	Laboratory tests
Rubber manufacturers	3	27
Governmental or Municipal Departments, etc.	1	8
Industrial concerns other than rubber	1	3
Miscellaneous	1	2
<i>Total</i>	6	40

W. G. WREN
Head of Chemical Division

Smallholders' Advisory Service

The Headquarters offices of the Smallholders' Advisory Service were moved on 1 October 1959 to a new air-conditioned building adjacent to the older Institute buildings.

Mr J. M. F. Greenwood, Acting Smallholders' Advisory Officer, was appointed Smallholders' Advisory Officer during February, the appointment being back-dated to 3 October 1958. Mr Greenwood was absent from Malaya on long leave from 4 June to 7 September 1959. During this period 'Che Shamsuddin bin Yub Ahmad was appointed to act as Smallholders' Advisory Officer, with responsibility for administration; Mr J. G. Samuel undertook full responsibility for supervision of field work.

'Che Shamsuddin bin Yub Ahmad, who had been seconded to the Federal Land Development Authority since 1 April 1958, returned to the Service on 1 May 1959. He later resigned his appointment as Assistant Smallholders' Advisory Officer and left the Service on 22 September 1959.

'Che Mohd Johar bin Mohd Rashid, Assistant Smallholders' Advisory Officer, returned from long leave on 2 June and was on duty for the remainder of the year.

Mr Wong Mun Yun, Senior Rubber Instructor at Headquarters, was promoted Assistant Smallholders' Advisory Officer from 1 January 1959 and was on duty throughout the year.

A second stenographer was appointed from 16 October, bringing the Headquarters clerical staff to a total of three.

Rubber Instructors

'Che Mohd Noordin bin Ahmad, Rubber Instructor at Machang was promoted Senior Rubber Instructor on his return from long leave on 17 March. He will continue to work in both Kelantan and Trengganu.

'Che Mohd Shafii bin Haji Ludin, Rubber Instructor at Temerloh was appointed to act as Senior Rubber Instructor from 1 November. On confirmation in his senior appointment, he will assume supervisory responsibility for our work throughout Pahang.

One Rubber Instructor resigned his appointment and two new Rubber Instructors were appointed, one after completion of an R.R.I.M. scholarship at the College of Agriculture. The cadre at the end of the year was one Senior Rubber Instructor and twenty Rubber Instructors. This number is inadequate for the present work of the Service, but recruitment must necessarily be slow because only those who have attended a three-year course and obtained the Diploma of the College of Agriculture, Serdang, are considered for appointment. Facilities at the College have been limited and there is a general shortage of qualified agriculturalists in Malaya.

Assistant Rubber Instructors

The title "Junior Rubber Instructor" was changed to "Assistant Rubber Instructor" from March 1959 but the qualifications and duties of this staff grade remained unaltered.

During the year, 7 Assistant Rubber Instructors resigned, 1 was dismissed and 62 new appointments were made to bring the total at the end of the year to 90. This increased staff will enable considerably more work to be done but the necessary intensification of effort will be possible only when the new men have gained experience and when close guidance can be provided by a sufficient number of Senior Officers and Rubber Instructors.

It is intended that the number of Assistant Rubber Instructors employed should be further increased during 1960 and applications to attend a training course for prospective new employees, commencing in February 1960, were invited at the end of the year. The actual numbers to be recruited during 1960 are at present uncertain but it is probable that the establishment will be increased to provide for 150 Assistant Rubber Instructors.

Staff List

A full list of junior headquarters and field staff in the Service on 31 December 1959 is provided as an appendix to this report. The list shows the date on which each man was appointed and the date on which he was posted to his present station. It will be seen that the great majority have but little experience in the Service and cannot be fully effective advisory officers in the immediate future.

Resignations during the year are shown at the end of the staff list together with a statement of long leave taken by field staff.

Recruitment and Training of Staff

With the increasing junior staff, particularly Assistant Rubber Instructors, it is essential that staff at Headquarters should be increased. An attempt was made to recruit experienced men for appointment as Assistant Smallholders' Advisory Officer, Division B but no sufficiently senior or well qualified applicants were available. Ultimately it is envisaged that all Division B Officers will be recruited from within the Service, but owing to serious losses of senior Rubber Instructors during 1953-54 this is not at present possible. The gap must be filled with outside appointments but only experienced personnel can be considered if the new appointments are to achieve their object of 'holding the fort' until Rubber Instructors now in the Service are sufficiently experienced for promotion.

Rubber Instructors receive their basic training at the College of Agriculture, Serdang, and scholarships for this purpose have been awarded by the Institute annually since 1951. Six scholarships tenable for three years from June 1959 were awarded and one tenable for two years. The latter award was made to a student already at the College who was selected to replace an R.R.I.M. scholar whose scholarship was terminated. At 31 December 1959 there were 16 R.R.I.M. scholars at the College of Agriculture. Four are expected to graduate in 1960, six in 1961 and six in 1962.

Two courses for prospective Assistant Rubber Instructors, attended by 52 prospective employees and 10 other students, were held at the R.R.I.M. Experiment Station. Of those trained, 45 were appointed Assistant Rubber Instructors.

The opportunity was taken to use these courses as refresher courses for a small number of Assistant Rubber Instructors already employed; nine attended at different periods during the two courses. It is apparent, however, that more

definite arrangements are needed for revision training for Assistant Rubber Instructors if the junior field staff is to be kept fully up to date and alive to current requirements and developments. Part of such training can be provided by supervising Rubber Instructors, but part must be given by Senior Officers.

Housing for Rubber Instructors

The policy of providing a house for each Rubber Instructor was continued and houses were completed and occupied at Taiping and Raub. Two houses were under construction at Johore Bahru and Kluang and plans were being prepared for two more at Temerloh and Segamat.

All stations where quarters are most urgently required, except Kuantan, now have houses but building will continue in the remaining stations. The difficulty continues to be in obtaining suitable house sites which in all cases has proved to be a lengthy process, particularly where State Land is involved.

Visitors from Abroad

Mr R. T. Wijewantha, Smallholders' Advisory Officer from the Rubber Research Institute of Ceylon spent the period from 11 to 19 December in Malaya during which time he visited smallholders' factories and replantings, Land Development Schemes in Negri Sembilan and Malacca and the R.R.I. Smallholders' School at Ayer Pa'abas. Mr Wijewantha met officers of the R.R.I.M. Research Divisions, the Rubber Industry (Replanting) Board, the Federal Land Development Authority, the Department of Agriculture, the Natural Rubber Development Board and the R.R.I.M. Experiment Station during a very full programme.

U Soe Myint and U Hla Maung, Officers of the Rubber Planting Project of the Agricultural and Rural Development Corporation of the Government of Burma visited the Institute from 2 to 17 January, during which time they spent three days making visits with the Smallholders' Advisory Service. Arrangements were made for the visitors to spend some time on Tanah Merah Estate and with the Rubber Industry (Replanting) Board after their visits to the Institute.

Mr A. J. Kallivayalil, a student sponsored by the Indian Council of Agricultural Research, attended a course for prospective Assistant Rubber Instructors and afterwards visited estates and smallholdings to gain field experience. Mr Kallivayalil was in Malaya from 17 August 1959 until 1 February 1960.

Mr. Ho Hon Quee of the Sarawak Department of Agriculture spent the period 9 to 11 December making visits to smallholdings and group processing centres. Other visitors who made brief visits to group processing centres were: Mr J. Cook, Director of Agriculture Sarawak; Mr J. C. Robertson of Edinburgh University; Mr T. Geikie of the Sarawak Department of Agriculture; Mr M. Leveque of Indo-China; Mr Norberto L. Demago from the Philippines; and Mr J. C. Caldwell of the Australian National University.

Correspondence

Mainly because of the increasing field staff, the volume of correspondence increased greatly during the year and a total of 7,355 incoming and 10,976 outgoing papers were dealt with: an average of 1,527 papers per month.

ADVISORY

Visits to Smallholdings by Field Staff

A table showing the numbers of visits made to smallholdings by Rubber Instructors and Assistant Rubber Instructors is given overleaf.

A 'first visit' is a visit to a holding which has not previously been seen by the officer concerned and the total number of 'first visits', 23,107, indicates the number of smallholders who were directly contacted by the Service during 1959. The number is approximately 6% of the estimated total number of smallholdings in Malaya. This appears to be a very small proportion but it must be realised that 1959 was the first year in which records of visits were kept. Other holdings have been contacted in previous years and the proportion of 6% refers to the one year only. Future records will provide cumulative figures for holdings directly contacted by the Service. Also in future years it is proposed that a card index shall be maintained to provide detailed information on each and every holding visited.

The figures show clearly the relative importance of replanting and new planting in the different States and the proportion of the total advisory effort devoted to these immature holdings. Visits to replantings account for 41.54% of the total and to new plantings 40.96%. Visits to mature holdings, at 17.5% of the total, will have been largely concerned with the improvement of processing techniques and particularly the introduction of group processing.

Forty-six per cent of the holdings visited received subsequent visits and most visiting was done by Assistant Rubber Instructors, although Rubber Instructors were able to undertake comparatively more visits per head. This reflects fairly accurately the comparative numbers of each grade of staff and their capabilities.

Planting of Rubber

New planting. New planting recorded by Rubber Instructors on individual holdings totalled 13,682 acres of which 8,034 acres (58.7%) were planted with clonal seedling material. The acreage planted was a little larger than in previous years, probably due to the easing of emergency restrictions which previously prevented planting in a number of undeveloped areas. For instance, new planting in Johore increased from 2,598 acres in 1958 to 3,258 acres in 1959 and in Pahang from 544 acres to 5,530 acres.

The increased use of clonal seedling material is difficult to explain as general interest in budgrafting among smallholders is real and apparently increasing. The general knowledge of a shortage of budwood of some clones may be a contributing factor and also the more remote position of the areas planted.

It is interesting to note the marked difference in planting material used in the two States with most new planting. In Johore, 4.4% of the planting was undertaken with clonal seedlings, but in Pahang 91% used this material. The probable explanation is that most plantings in Pahang are Malay-owned while those in Johore will include a greater proportion of Chinese-owned holdings. It is well known from observations by field workers that many Chinese smallholders prefer to budgraft their holdings and these figures bear out the observations very clearly.

SUMMARY OF VISITS BY RUBBER INSTRUCTORS AND ASSISTANT RUBBER INSTRUCTORS DURING 1959

State	Mature rubber				Replanting				New planting			
	First visit		Subsequent visit		First visit		Subsequent visit		First visit		Subsequent visit	
	R.I.	A.R.I.	R.I.	A.R.I.	R.I.	A.R.I.	R.I.	A.R.I.	R.I.	A.R.I.	R.I.	A.R.I.
Malacca	34	776	2	20	131	946	9	40	82	91	50	6
Kelantan	16	54	—	16	45	257	—	123	35	2,265	—	415
Johore	403	513	188	224	725	1,944	438	857	576	1,194	234	435
Pahang	161	262	28	115	292	468	102	199	353	832	100	330
Trengganu	—	119	—	13	—	448	—	57	—	1,246	—	202
Selangor	213	377	75	257	417	642	183	367	19	86	18	2
Negri Sembilan	216	77	95	57	702	139	356	275	433	863	192	262
Kedah	105	229	5	280	187	659	118	561	119	783	112	882
Perak	219	409	153	194	195	758	189	1,181	262	730	242	362
<i>Total</i>	1,367	2,816	546	1,176	2,694	6,261	1,395	3,660	1,879	8,090	948	2,896
All Visits, Total	5,905 = 17.50%				14,010 = 41.54%				13,813 = 40.96%			

Smallholders' Advisory Service: Advisory

NEW PLANTING REPORTED BY RUBBER INSTRUCTORS, 1959

State	Total	Planted clonal seedlings		Budgrafting on previous plantings
	Acres	Acres	%	Acres
Selangor	—	—	—	—
Negri Sembilan	584	389	66.6	18
Malacca	189	155	82.0	20
Perak	782	538	68.8	482
Johore	3,258	145	4.4	2,114
Pahang	5,530	5,032	91.0	2,349
Kedah/Perlis	1,827	1,100	60.2	349
Penang/P. Wellesley	—	—	—	—
Kelantan	106	26	24.5	66
Trengganu	1,406	649	46.1	8
<i>Total</i>	13,682	8,034	58.7	5,406

Budgrafting on previously planted holdings, at 5,406 acres, is considered satisfactory as budgrafting at this rate continues to indicate that all holdings planted with ordinary seed are being budgrafted in due time as shown by the table below.

Over a period of 5 years, 15,003 acres of ordinary seed plantings were reported and over the 5 years extending one year later than the period of planting, 17,356 acres were reported budgrafted. The apparent excess of 2,353 acres budgrafted will be partly explained by the variation in time of budding which cannot be assessed and partly by the planting of budded stumps or stumped buddings. The area planted with these materials is known to be small and it can be accepted that ordinary seedling plantings have, in all except very few cases, been budgrafted.

BUDGRAFTING ON NEW PLANTINGS

Year	Total planting	Planted clonal seedlings	Balance (ordinary seed for budgrafting)	Reported budgrafted
1954	3,360	1,865	1,495	—
1955	8,050	6,542	1,508	2,733
1956	13,055	11,298	1,757	2,529
1957	11,281	8,171	3,110	2,613
1958	10,837	3,704	7,133	4,075
1959	13,682	8,034	(not yet buddable)	5,406
<i>Total</i>	60,265	39,614	15,003	17,356

Block Schemes for New Planting

There has been a great increase in controlled new planting schemes whereby blocks of land, ranging from 252 acres to 4,000 acres each, are developed as single units for later sub-division into smallholdings of 6-10 acres each. These are alienated to individuals who, as settlers, have jointly developed the whole area. The larger of these schemes are financed by the Federal Land Development Authority which provides management and advances all necessary development funds to approved schemes initiated by State Land Development Boards. The advances, including management costs, are recoverable from the settlers after the areas developed come into production. The smaller schemes are normally the responsibility of State Governments which advance different sums to cover certain costs of development. These sums do not cover the whole cost of development, nor do they necessarily cover the employment of a manager for each scheme or group of schemes. Control is exercised by State Land Development Boards operating through District Development Boards of which a Government administrative officer is usually chairman and executive. Provisions for supervision and control on the ground vary, as do the methods of development. Some schemes have been developed from jungle entirely by the settlers themselves. Others have been developed and maintained by contractors up to six months after planting of rubber seedlings and cover crops, at which stage settlers enter the area to take over individual holdings. Variation in the amount of work undertaken by contractors within these extremes and the stage at which individuals take over the holdings is considerable.

No accurate survey of results has yet been made but it appears from casual observation that the greater the proportion of development undertaken by the settlers themselves, the more successful the schemes in the long run. The difficulty in settler-developed schemes is the provision of strict management and leadership to guide and control development during the early, arduous stages when the results of communal labour can give but little satisfaction to the individual. Once the initial development is complete, however, the individual appears to value his holding very much more highly than where a ready-developed holding has been allotted to him. Thus, although it appears on the surface that management problems are avoided by the employment of contractors in the early stages, these problems are, in fact, only postponed. Very similar problems arise during the early months when the partially developed holdings are in the hands of settlers; at this time, essential routine maintenance yields no tangible return and secondary cash crops are not yet in production. At this stage it is difficult to maintain enthusiasm, even in individually allocated holdings, and continual encouragement and persuasion from the authorities are essential, although often difficult to provide with the limited staff employed.

A summary of the plantings within controlled schemes, as known to us, is shown in the table opposite.

Budgrafting was completed on the pioneer scheme at Ayer Lanas, Kelantan, previously planted and, in addition to the schemes shown in the table, seven schemes totalling some 8,000 acres were planned but not yet implemented in Johore. A number of further State-operated schemes were also in various stages of planning to provide assisted new planting blocks in all States except Selangor and Perak.

Smallholders' Advisory Service: Advisory

NEW PLANTING OF RUBBER IN LAND DEVELOPMENT SCHEMES, DECEMBER 1959

State	No. of schemes	Total area for planting rubber	1959		
			Planted clonal seedlings	Planted ordinary seed for budgrafting	Budgrafted
			Acres	Acres	Acres
Kedah	11	17,262	780	1,178	1,500
N. Sembilan	7	3,490	—	2,334	—
Malacca	6	6,622	—	2,402	900
Trengganu	1	2,400	—	500	—
<i>Total</i>	25	29,774	780	6,414	2,400

Advice on New Planting Schemes

Advice to the appropriate authority during planning of rubber plantings has been given by the Service and has been followed by later advice to scheme managers and settlers. This work has occupied Mr Wong Mun Yun full time and other officers intermittently, as initial planning has required visits to each individual scheme and the preparation of detailed planting and maintenance programmes. This work is expected to increase during 1960 when a greater part will be played by Rubber Instructors and Assistant Rubber Instructors in contact with settlers.

The major problem on which advice has been provided was the selection of rubber planting materials. Only where schemes are small or planned prior to the main schemes have clonal seedlings been used. In all other schemes budgrafted material has been recommended as it is believed that, in properly managed schemes covering large areas, clones selected for the area concerned will provide the best returns. Generally it has been recommended that part of each area should be budgrafted with one or two well proved clones and a smaller portion with one or two of the most promising newer clones which, although not fully proven, are sufficiently well tested to justify selection for use on smallholdings.

Planting Material for New Plantings

The large areas planted for later budgrafting will greatly increase the amount of budwood required for use by smallholders and it was apparent that nurseries maintained by the Rubber Industry Smallholders Planting Material Scheme (1956) would not be adequate to meet the demand. The pace of development is such that new nurseries established from seed cannot be developed in time to provide the material required. At the end of the year, therefore, it was agreed that budwood from commercial sources must be accepted for use by smallholders and development schemes under certain conditions. Methods for obtaining reliable supplies of commercial budwood were considered and during December a plan for the registration of possible suppliers of budwood surplus to estate requirements was put into effect. A circular seeking the assistance of estates was drafted at the Institute and issued by the Chairman of the Boards of Administrators of the Government Rubber Replanting Schemes as the authority responsible for the provision of planting materials for all smallholders. Even if the response to this

approach comes well up to expectations there will still be an acute shortage of budwood during 1960 and 1961.

The larger development schemes, under the control of the Federal Land Development Authority, have generally made provision for nurseries within the schemes to provide the planting material required and a nursery has been established by the Malacca State Government to supply the greater part of requirements for new planting schemes within the State. But a large number of small State-operated schemes elsewhere have made no definite provision for obtaining budwood. The supply situation is expected to become critical therefore and further action is urgently required at State or Federal level.

Replantings

Arrangements for co-operation with the Rubber Industry (Replanting) Board whereby Rubber Instructors are notified of all holdings for which grant payments are deferred and all holdings to which the final grant instalment has been paid, were put into full effect. This information, regularly received from Officers of the Replanting Scheme, enabled field staff of the Service to visit all holdings requiring advice without waste of time in locating holdings and without unnecessary visits to holdings where little useful work could be done.

Advisory work to replanters continued to occupy a large proportion of the time of field staff but, apart from records of visits, no data were collected—detailed and accurate information on all replantings is available from the Rubber Industry (Replanting) Board, Fund 'B'.

Survey of Smallholdings Replanted 1952-53

A field survey of 1,097 smallholdings, replanted in 1952-53, which had received the final instalment of the Replanting Grant was completed in 1958. Following analysis of the data, a report was issued in April 1959 as Document 12 of the *Archives of the Rubber Research Institute of Malaya*. The general conclusions reached were as follows:

- (a) Growth on replantings receiving the final grant payment in or before 1957 was not up to expectation. Growth of budgrafted trees was relatively poorer than that of clonal seedling trees. Poor growth can be attributed partly to the high stand of trees per acre commonly found, partly to the vegetation allowed between the rubber rows and partly to the poor general maintenance indicated by the delayed payment of the final instalment of many grants. The retarding effect of high density planting must be expected to increase as the trees become older.
- (b) Budgrafting, although popular, was not well carried out, only two-thirds of supposedly budded holdings being 90% or more budgrafted.
- (c) Tapping of undersized trees was common on budgrafted holdings but clonal seedling trees in tapping had attained the accepted standard of tapability.
- (d) Malay replantings were smaller than those owned by other races and growth on them was rather poorer. Malay holdings were, however, as well maintained as other holdings and hence equally successful by the standards of the Replanting Scheme.

The survey was undertaken with two objects: first to assess the results of the Replanting Scheme and second to indicate matters to which advisory effort should be directed. A complete answer to the first question was not obtained in that the holdings considered were planted during the first year of the Scheme or planted in the preceding year and admitted to the Scheme during its first year. Many were not planted strictly in accordance with the requirements of the Scheme and so cannot be considered representative. With this proviso, it is considered that the survey showed the Replanting Scheme to be a success, in that the majority of replantings receiving grants were of a satisfactory standard and could be expected to provide economic returns to the owners in a reasonable time and over a long period.

The indications of advisory requirements were clear. Attention is needed to improving budgrafting practices, reducing planting density, and discouraging premature tapping of young trees. These points were brought to the attention of Rubber Instructors and particular efforts made in teaching correct tapping methods including the opening of young trees for tapping at the correct time. It is noticeable that the points requiring attention concern faults which give rise to intangible and long-term losses which, although real, are difficult to demonstrate and very difficult to bring home to the smallholder. For instance, the actual budgrafting operation was well executed but it was unusual to find uniform budgrafting of all trees and cutting-back carried out as a single operation over a complete holding. Improvement in management problems of this type requires improved education and general understanding which can come only with time.

Supply of RRIM 600 Series Clones to Smallholders

Budwood of the more promising RRIM 600 Series clones continued to be sold from the RRI Experiment Station to smallholders. Interest in these new clones is considerable, particularly among Chinese smallholders undertaking new planting; the budwood sold is shown in the table overleaf.

Very small quantities of the clones (RRIM 604, 612, 614) not now considered among the most promising of the Series were sold but only to owners of holdings in the 25-100 acre class who insisted on experimenting with these clones. Sales to smallholders were restricted to clones considered promising.

RRIM 628, from the second selection of the Series, has attracted attention by its very high yield and there is a demand for this clone from smallholders. Applicants have been informed of the poor vigour and thin bark of RRIM 628 which makes it not generally suitable for use by the average smallholder.

Manufacture

Sales of latex by smallholders were reported by Rubber Instructors to total 5,524 tons (dry rubber) during the year, 1,633 tons being processed into sheet at central factories and 3,891 tons being finally exported as concentrated latex.

Central processing of smallholders' latex may be undertaken in any of four ways. The latex may be purchased from the smallholder and processed in bulk by a co-operative factory producing sheet, a proprietary factory producing sheet or a large commercial organisation producing concentrated latex. Alternatively the latex may be processed by the producer himself, using the facilities of a group

RRIM 600 SERIES BUDWOOD SUPPLIED TO SMALLHOLDERS DURING 1959

Clones	Johore	Malacca	Perak	Selangor	Pahang	Kedah	N. Sembilan	Kelantan	Trengganu	Total
RRIM 600	48	3	55½	—	85	57	—	9	10	267½
603	244	—	40	—	140	112	2	12	—	550
604	1	—	4	—	4	—	—	—	—	9
605	281	5	20	38	408	79	122	7	3	963
606	36	—	—	—	82	11	—	—	5	134
607	89	—	39	—	4	22	—	12	—	166
610	12	4	25	—	27	44	—	2	2	113½
612	—	—	—	—	—	—	1	—	—	1
613	—	—	—	—	4	—	—	—	—	4
614	—	—	2	—	9	—	—	—	—	11
623	76	6	97	4	249	81	72	22	3	610
628	11	—	—	—	—	—	—	—	—	11
<i>Total</i>	798	18	282	42	1,012	406	197	64	21	2,840

processing centre. At the end of the year, three co-operative factories were operating together with the R.I.D.A. factory at Grisek, Johore, which can be considered in the same group. In addition ten small proprietary factories producing sheet and twenty-five organisations purchasing latex for re-sale to commercial factories for concentration were in operation. The rate of production per month by these bulk processing organisations is shown in the table.

CENTRAL PROCESSING OF SMALLHOLDERS' LATEX. AVERAGE MONTHLY PRODUCTION 1959

State	Latex collection for sheet production		Collection for sale as latex
	Co-operative factories	Proprietary factories	
	pikuls d.r.c.	pikuls d.r.c.	pikuls d.r.c.
Perak	23	127	136
Selangor	240	486	1,595
Malacca	12	—	—
Johore	380	1,298	1,908
Negri Sembilan	—	—	410
Kedah	—	—	514
<i>Total</i>	655	1,911	4,563

Two large latex purchasers ceased to take smallholders' latex during the latter half of the year owing to the reduced demand for concentrated latex, but the collection organisations supplying smallholders' latex to these purchasers discovered other outlets for the latex and continued their collections.

Group Processing Centres

At group processing centres, smallholders' latex is not purchased but is processed into sheet by the producer himself, using central facilities provided co-operatively, communally or by an individual. In co-operative or communal centres, each producer contributes to the initial cost of the factory and smokehouse required, whereas in individually owned centres the users do not contribute to the capital cost but pay a small rent for the facilities provided. In either case a charge is made for smoking as a smokehouse fireman must be employed.

Thirty-three group processing centres were in operation at 31 December, 1959, as shown in the table overleaf.

Improvement of the smallholder's product and the return he obtains for it through group processing centres is being undertaken in four steps. First, provision of the centre improves the quality of the product, Grade 1 and Grade 2 sheet being readily produced instead of the Grade 3 or Grade 4 sheet considered normal on smallholdings. Second, provision of a smokehouse permits economic smoking of the product without effort by the individual producer. This enables the sheet to be accurately graded at the time of sale and a fair price to be obtained. Third, introduction of bulk marketing from the centre, made possible by the

GROUP PROCESSING CENTRES AT 31 DECEMBER, 1959

State	Number of centres	Number of users	Mean monthly output pikuls	Number of smokehouses
Kedah	3	30	41	—
Perak	9	135	217	1
Selangor	3	46	73	3
Malacca	3	67	68	3
N. Sembilan	1	12	16	1
Johore	6	185	398	2
Pahang	8	126	188	6
<i>Total</i>	33	601	1,001	16

production of good quality smoked sheet, permits sale of the produce to larger dealers, eliminating the charges and profits of the small kampong dealer. Fourth, the costs of production may be reduced by introduction of bulk processing of all latex received at the centre. This final step to fully centralised processing may, in fact, not be justified in many cases. The attraction of group processing centres is their simplicity in organisation and operation: little supervision is necessary and, as each producer's sheet is individually marked, no accounts or records are required except in connection with bulk marketing where, because sales are normally made jointly, paper work is of the simplest. When bulk processing is introduced, accurate d.r.c. estimations and accurate records of each producer's deliveries of latex become essential, problems of management are introduced with the employment of paid labour, and technical problems arise in the transport and preservation of latex. Further investigations are required before the introduction of bulk processing at small centres can be confidently recommended, but where interest is shown by the smallholders concerned this refinement will be encouraged.

It can be seen from the table above that of the 33 group processing centres operating, only 16 have smokehouses. Some arrange smoking of the sheet produced at a nearby commercial smokehouse and some, more recent centres, are planning to erect smokehouses. At the others, smallholders are at present satisfied with the increased return obtained though improvement in the quality of sheet alone. This cannot be considered satisfactory and every effort will be made to persuade these groups of the additional advantages to be obtained from the production of smoked sheet.

Bulk marketing of the produce has been introduced at three of the centres shown above. At one, marketing is undertaken by the operators; at the other two, Co-operative Marketing Societies have been formed with the assistance of the Department of Co-operative Development. This is considered the most satisfactory method of marketing for group processing centres and it is hoped that further Co-operative Marketing Societies will be established.

INFORMATION AND EDUCATION

Training courses at three levels of theoretical instruction were continued and 22 courses attended by 481 students completed. Details are shown in the table. Twenty-six courses of different types were in progress at the end of the year.

TRAINING COURSES FOR SMALLHOLDERS, 1959

Type and location	Students enrolled	Students completing courses		Examination passes and certificates awarded	
		Number	Percentage	Number	Percentage
Extension Courses (4)					
1 Batu Pahat (Chinese)	30	23	76.7	15	65.2
1 Batu Pahat (Malay)	30	19	63.3	15	78.9
1 Kuala Pilah (Chinese)	34	17	50.0	14	82.3
1 Padang Lati (Malay)	26	22	84.6	16	72.7
Standard Courses (14)					
6 Ayer Pa'abas (Malay)	86	86	100.0	71	82.5
1 Ayer Pa'abas (Chinese)	18	18	100.0	15	83.3
1 R.R.I. Experiment Station (Malay)	28	28	100.0	26	92.8
6 in kampongs (Malay)	137	101	73.7	73	72.3
Practical Courses (4)					
In kampongs (Malay)	92	78	84.8	No examination	
<i>Total</i>	481	392		245	
<i>Percentage</i>			81.5		78.75

Greater attention was paid to Practical Courses, in which instruction is given by demonstrations followed by practical work, with a minimum of theoretical explanation, and while only 4 such courses were completed 22 more were in progress at the end of the year. Practical Courses occupy half a day each week for a period of six or seven months and certificates are awarded, without examination, to those who have attended regularly and missed no more than 4 sessions during the course. The standard achieved, inevitably, varies according to the experience and enthusiasm of the instructor, but to ensure an acceptable minimum standard it is intended to introduce simple oral tests for all practical course students completing courses next year. Only those who achieve the required standard will be awarded certificates which will then have a more definite value.

It is noticeable that the residential (standard) courses at Ayer Pa'abas and the R.R.I.M. Experiment Station produced a better overall result than similar courses provided at kampong centres. This is explained by two facts. First, at the residential centres all facilities for demonstrations and practical work are immediately to hand. Second, the instructors at Ayer Pa'abas are fully experienced in running a course to a set programme while those at the R.R.I.M. Experiment Station work under close supervision from headquarters. In the kampongs it is often difficult to find sites for certain aspects of the practical work taught and it is

not usually possible to follow rigidly a set programme. This makes teaching more difficult and also requires students to grasp a story which cannot always be presented in logical sequence. On the other hand the duration of the two types of course should be taken into consideration. A residential course runs continuously for one month whereas those conducted in the kampong occupy one day each week over a period of six months. It may thus be considered that those passing examinations at the end of a six-month course have really mastered the subject and will retain what they have learnt more easily than those completing a one-month course. Allowing for these factors, it is considered that average pass rates at 86.2% for residential courses and 74.3% for courses in the kampong are reasonable.

An average of 74.6% of students enrolled in all types of course conducted in the kampong completed their courses. This is satisfactory considering the difficulties involved in weekly attendance for a period of six or seven months. All students attending residential courses completed their courses.

Presentation of Certificates

At the conclusion of some courses the students arranged parties at which certificates were presented to successful students by local leaders or officials. We are grateful to the following persons for making such presentations.

The Hon'ble The Chief Minister, Malacca	The Hon'ble Inche Abd. Ghafar bin Baba
Yang Amat Mulia Dato Undang Jelevu	
The Hon'ble The State Secretary, Perlis	Raja Mokhtar bin Raja Yaacob, M.C.S.
The District Officer, Tanah Merah	Enche Hashim bin Hj. Mohamed (Dato Wira Jaya)
The District Officer, Pasir Puteh	Enche Wan Abd. Rahman bin Ismail (Dato Bentara Setia)
The District Officer, Kubang Pasu	Tuan Syed Noh Shahabudin
The Director, R.R.I.M.	C. E. T. Mann Esq.

Such official interest and encouragement in our work is very much appreciated both by the Institute and the students.

Occupations of those Completing Courses

Towards the end of the year the majority of students who had completed courses earlier in the year were contacted by Rubber Instructors to discover whether the knowledge gained at courses was being put to practical use. Findings are shown in the table opposite.

Of those listed as not employed on smallholding rubber, 4 were working with the Rubber Industry (Replanting) Board and 1 with the Department of Agriculture. Ten others were following agricultural pursuits, 19 were continuing as students and 11 were teaching. The remaining 25 were following gainful occupations where it was unlikely that their knowledge of rubber would be of value.

The large number of students is explained by the fact that these boys come from families owning rubber land and attend rubber courses (particularly the higher level extension courses) during their penultimate year at school. They are

OCCUPATION OF STUDENTS COMPLETING COURSES IN 1959

Course	Employed in rubber work			Not employed on smallholding rubber	Not contacted	Total
	Full time	Part time	Per cent			
Extension Courses (4)	33	22	67.9	25	1	81
Standard Courses						
Ayer Pa'abas (5)	46	6	78.8	11	3	66
R.R.I.M. Expt. Station (1)	21	2	82.1	5	—	28
In kampongs (6)	60	11	70.3	29	1	101
<i>Total</i>	160	41	—	70	5	276
<i>Percentage</i>	58	14.8	—	25.4	1.8	100

accepted for training because of their connection with rubber holdings and their technical knowledge is usually put to good use. Teachers also, in the course of their work, use the knowledge gained.

Training Courses for Other Organisations

Special training courses were provided for staff of the Rubber Industry (Replanting) Board and the Department of Agriculture, Sarawak. Twenty-eight Junior Replanting Inspectors attended a three-week refresher course at the R.R.I. Experiment Station from 20 July to 8 August to bring their knowledge of replanting techniques up to date. Seventeen students from the Sarawak Department of Agriculture spent three weeks at Ayer Pa'abas from 30 November to 18 December to study methods of tapping and processing latex into smoked sheet.

In addition to those attending the special course, 20 other students sent by the Department of Agriculture, Sarawak, attended normal courses at Ayer Pa'abas in groups of three or four on each course. Three students from Brunei also attended courses at Ayer Pa'abas.

A number of students from other organisations are normally accepted on courses for prospective Assistant Rubber Instructors, although the number accepted is small because of our own staff requirements. During 1959 two students from the Rubber Industry (Replanting) Board, three from the Federal Land Development Authority, three from the Rural and Industrial Development Authority and three private students (one of whom came from India) attended these courses.

Courses at Rural Training Centres of the Department of Agriculture

Courses provided by the Department of Agriculture at their Rural Training Centres continued to include brief sections on rubber planting. Regular talks or brief periods of instruction were given by Rubber Instructors or Assistant Rubber Instructors at five Rural Training Centres.

Mobile Demonstration and Film Units

A second Land Rover was purchased in August and provided with the equipment necessary both for demonstrations on good sheet making and the showing of instructional films. During the last four months of the year this unit provided

35 demonstrations as shown in the table. Other demonstrations on processing techniques were given by Rubber Instructors, using locally available equipment, at 155 centres. It is estimated that some 3,000 smallholders witnessed these demonstrations, many of them taking part in sheet making as a conclusion to the demonstration.

The existing mobile film unit continued to provide film shows at kampong centres but was not in use during the Muslim fasting month, nor during November and December when the operator was on long leave. One hundred and thirty-eight evening film shows were given during the year and in addition films were shown in connection with all training courses and most agricultural shows.

USE OF MOBILE UNITS, 1959

State	Processing demonstrations	Film shows
Selangor	8	9
Negri Sembilan	4	22
Malacca	6	5
Perak	2	28
Johore	5	22
Pahang	—	17
Kedah/Perlis	10	8
Kelantan	—	6
Trengganu	—	21
<i>Total</i>	35	138

Agricultural Shows

Few agricultural shows lasting more than one day were held during 1959 but at three major shows in Pahang, Johore and Malacca, smallholders' sheet-making competitions were arranged by the S.H.A.S. During seven days of competitions 84 smallholders took part and prizes were awarded to winners by the different Show Committees.

At the MAHA Show in Kuala Lumpur a national rubber sheet making competition was held and entered by fifty-four competitors drawn from all States. This competition was arranged and largely judged by S.H.A.S. staff.

At other agricultural shows, exhibits were provided by Rubber Instructors using display material from the Institute and in most cases supported by film shows.

Publications

Revised Jawi and Chinese editions of the booklet 'Replanting on Smallholdings' and Jawi, Chinese and English editions of the booklet 'Good Tapping' and the leaflet 'Manuring of Young Rubber' were issued early in the year. A revised edition of the leaflet 'Lalang Control with Dowpon' was prepared and was with the printer at the end of the year.

A series of six posters was produced to illustrate the technique for making good quality sheet, emphasising the importance of cleanliness throughout and the smoking of sheet to obtain the maximum return. These were designed by Miss J. Metcalf and executed in bold colour with captions in Rumi. The two key posters, illustrating technique, were also produced with Chinese captions and an Iban version was prepared for use in Sarawak. The posters provide illustration as a basis for talks by Rubber Instructors and following the talks are left as a reminder of the points raised. A second series of five posters, dealing with tapping, was designed by Mrs W. J. Baulkwill and was with the printer at the end of the year.

Rubber Industry (Replanting) Board Publicity Campaign

In 1959 the annual publicity campaign, arranged by the Rubber Industry (Replanting) Board to encourage smallholders to take advantage of the Replanting Scheme, took the form of discussions led by selected speakers in the kampongs. Rubber Instructors or Assistant Rubber Instructors attended each discussion group to provide information on the work of the Smallholders' Advisory Service and to answer technical questions on the replanting of rubber.

J. M. F. GREENWOOD
Smallholders' Advisory Officer

Appendix

SMALLHOLDERS' ADVISORY SERVICE. JUNIOR STAFF, 31 DECEMBER 1959

Headquarters Staff

Date of Appointment

Mohd Noordin bin Jantan	Clerk	1.12.46
Chye Ngok San	Stenographer	9.11.53
Mrs Tong Poh Eng, Katherine	Stenographer	16.10.59
A. Chelliah	Field Assistant	1.10.37
Shurki bin Rais	Driver/Projectionist	1. 8. 48
	Transferred to SHAS 1st July, 1955	
Annuar bin Hussin	Driver/Projectionist	15. 5.59
Mohd Ali bin Yaacob	Peon	1.10.59

Long Leave During 1959

Chye Ngok San from 9 November to 8 February, 1960

Shurki bin Rais from 1 November to 31 January, 1960

Field Staff

<i>Senior Rubber Instructor</i>	<i>Date of Appointment</i>	<i>Present Station</i>	<i>Date of Posting</i>
Mohd Noordin bin Ahmad	1. 6.41	Machang	1. 4.58
Promoted	17. 3.59		

Rubber Instructors

Abd. Rahman bin Panjang Aris	1. 5.37	Batu Pahat	21.10.52
Ahmad bin Haji Salleh	3. 1.55	Muar	2. 6.56
Ahmad Hamidy bin Mohd Zam	17. 5.55	Jitra	27. 2.58
Ahmad Mahidin bin U. Shaaban	1. 5.58	Seremban	1. 8.58
Ahmad Mazlan bin Mohd Yusoff	1. 5.56	Malacca	4.12.56
Kassim bin Hassan	1. 5.38	Taiping	1.11.59
Mohd Piah bin A. M. Aras	1.11.36	Tampin	15.12.54
Mohd Shafii bin Haji Ludin	1. 5.34	Temerloh	2. 9.58
Chan Seng Kiat	1. 5.40	Sungei Patani	25. 1.56
Chen Chen Chuan	1. 5.53	Kajang	20.10.58
Chew Kok Peng	1. 3.59	Kuantan	2.11.59
Lee Buck Heng	17. 5.55	Batu Pahat	6. 5.58
Leong Mun Wai	21.10.57	Segamat	6. 3.58
Lim Hong Hai	21. 4.52	Seremban	23. 4.58
Anthony G. Mak	4. 6.49	Ipoh	1. 5.57
Ng Kar Foo	18. 5.59	Kuala Kangsar	3.11.59
Pang Tung Wah	1. 6.55	Sitiawan	29.10.57
Phang Ah Kow	1. 5.58	Klang	1. 8.58
Soh Ah Leng	21. 4.54	Raub	1. 8.58
Tan Poh Hock	21. 4.52	Johore Bahru	12.12.55

Resignation 1959

Chin Kai Ming w.e.f. 1.5.59

Long Leave 1959

Mohd Noordin bin Ahmad	8.11.58	to	16. 3.59
Chen Chen Chuan	1. 5.59	to	31. 7.59
Lim Hong Hai	1. 7.59	to	14.10.59
Abd. Rahman bin P. Aris	14.12.59	to	28. 7.60

Smallholders' Advisory Service: Appendix

<i>Assistant Rubber Instructors</i>	<i>Date of Appointment</i>	<i>Present Station</i>	<i>Date of Posting</i>
Abd. Aziz bin Yusof	1. 6.56	Sik	17. 9.56
Abd. Bari bin Abd. Hamid	1.11.57	Jerteh	26. 7.59
Abd. Ghani bin Abd. Rahman	1.11.57	Mersing	1. 1.59
Abd. Hamid bin Hj. Osman	1.11.57	Bukit Badong	25. 2.58
Abd. Hamid bin Mohd Hashim	1. 1.59	Temerloh	1. 1.59
Abd. Jalil bin Haji Yusof	23. 4.54	Kota Tinggi	15. 6.59
Abdullah bin Akad	19. 4.54	Manong	2. 9.59
Abdullah Zawawi bin Omar	1. 5.59	Tapah	8. 8.59
Arund bin Katun	15. 5.59	Labu	8. 8.59
Abu Bakar bin Mohd Yassin	15. 8.49	Lenggong	4.11.59
Promoted	4. 8.53		
Abu Bakar bin Ahmad	25. 4.54	Ayer Pa'abas	1. 8.59
Abu Bakar bin Haji Ahmad	1.11.57	Kuala Pilah	19. 5.58
Abu Bakar bin Haji Yaacob	1.11.57	Grik	22. 2.58
Baharuddin bin Dahalan	1. 6.56	Kota Sarang	
		Semut	12. 5.58
Baharuddin bin Hussin	1. 1.59	Kemaman	8. 6.59
Haji Mahfutz bin Haji Elias	1. 1.41	Pekan	5. 8.59
Promoted	1. 2.56		
Hamdzah bin Abdullah	1. 7.52	Bentong	1. 5.59
Promoted	1. 2.56		
Haron bin Markhan	1. 6.56	Dabong	3. 8.59
Hermeney bin Nor Rashid	1. 5.59	Muar	8. 8.59
Ibrahim bin Haroun	20. 4.54	Kangar	10. 8.59
Ithnin bin Mohd Noh	1. 1.59	Port Dickson	8. 6.59
Johari bin Hussin	1. 5.55	Selama	3. 8.59
Kamaruddin bin Ariff	1.11.57	Segamat	28. 4.58
Kamaruddin bin Mahmood	1. 5.59	Kuala Brang	25. 7.59
Kamarudzaman bin Mohd Sidek	19. 4.54	Chalok	9. 8.59
Khalil bin Abdullah	1. 6.56	Pasir Puteh	8. 8.59
Mahmud bin Mohd Yassin	1. 6.56	Tanah Merah	5.12.57
Mansor bin Haji Salleh	15. 7.47	Banting	17. 8.59
Promoted	24. 5.56		
Mohd Ardenan bin Hj. Ismail	1.11.57	Benta	18. 1.59
Mohd Hanuddin bin Manaf	26. 4.54	Pontian	2. 8.59
Mohd Noh bin Hussein	25. 4.54	Malacca	15. 6.59
Mohd Rofli bin A. Sulaiman	1. 1.59	Parit Sulong	8. 6.59
Mohd Sahari bin Sulaiman	1. 5.59	Pagoh, Muar	3. 9.59
Mohd Yunus bin Mohd Aris	20. 4.54	Baling	7. 9.59
Mohd Yunus bin Shariff	1. 5.59	Serdang, Kedah	8. 8.59
Mohd Zabri bin Abd. Hamid	1. 5.59	Masjid Tanah	8. 8.59
Mustapha bin Mohd Yusof	1. 1.59	Grisek	8. 6.59
Mustapha bin Hj. Mohd Pilus	1. 1.59	Batang Kali	15. 7.59

	<i>Date of Appointment</i>	<i>Present Station</i>	<i>Date of Posting</i>
Nik Idris bin Nik Daud	1. 6.56	Kuala Trengganu	28. 5.58
Osman bin Abd. Ghani	1. 1.59	Kuala Krai	8. 6.59
Ramli bin Haji Salleh	1. 5.55	Machang	28. 2.56
Ramli bin Seran	1. 1.59	Chembong	8. 6.59
Rosli bin Kassim	15. 5.59	Parit	4.11.59
Shahabudin bin Mohd Kamil	1. 1.59	Masai	8. 6.59
Shamsuddin bin Abd. Hamid	1. 5.59	Jitra	3. 8.59
Sulaiman bin Mat Tekor	1. 1.59	Gajah Mati	8. 5.59
Wan Mohd Isa bin Wan Mohd Ali	1. 1.59	Maran	8. 6.59
Yaacob bin Hohd Nor	1. 5.59	Batu Kikir, Kuala Pilah	8. 8.59
Zainal Abidin bin Abdullah	1. 6.56	Seremban/Jelebu	1. 6.56
Zainuddin bin A. Hassan	1. 5.59	Kerdau	8. 8.59
Zul Ghazali bin Shahidin	1. 6.56	Pasir Mas	15. 9.59
Au Ah Sin	1.11.57	Kulim	25. 2.58
Chan Meng San	1. 1.59	Batu Gajah	8. 6.59
Chin Then Voon	1. 1.59	Triang	8. 6.59
Chua Beng Eng	1. 5.59	Jasin	4. 9.59
Kwan Yin Nein	1. 1.59	Tangkak	8. 6.59
Lee Kim Thian	1. 5.59	Bahau	8. 8.59
Mak Khong Hee	1. 1.59	Kuala Klawang	1.12.59
Tan Soon Huat	1.11.57	Kluang	12. 6.58
Teh Tong Seong	1. 5.59	Gurun	3. 8.59
Teng Hock Phai	1.11.57	Jitra	5. 5.58

On Probation

Abd. Aziz bin Yatim	16.11.59	Malacca	16.11.59
Abd. Hamid bin Hj. Lasim	16.11.59	Malacca	16.11.59
Abd. Wahab bin Mohd Satir	16.11.59	Ipoh/Slim River	16.11.59
Badaruddin bin Hj. Isa	16.11.59	Ipoh/Tk. Anson	16.11.59
Hassan bin A. Kamaruddin	19.11.59	Taiping/B. Kurau	19.11.59
Ibrahim bin Haji Hassan	16.11.59	Jitra	16.11.59
Khalid bin Hassan	16.11.59	Batu Pahat	16.11.59
Mohd Abu Alhuda bin Hj. Hassan	16.11.59	Jitra	16.11.59
Mohd Ali bin Mohd Derus	16.11.59	Seremban	16.11.59
Mohd Kamal bin Abd. Salam	16.11.59	Temerloh	16.11.59
Mohd Tahir bin Abd. Majid	16.11.59	Taiping	16.11.59
Mohd Yusof bin Abdullah	16.11.59	Machang/Pasir Mas	16.11.59
Mohd Yusof bin Kassim	16.11.59	Temerloh	16.11.59
Rosli bin Mohd Yusof	19.11.59	Segamat	19.11.59

Smallholders' Advisory Service: Appendix

	<i>Date of Appointment</i>	<i>Present Station</i>	<i>Date of Posting</i>
Syed Alwi Aljunid bin Sy. Ahmad Aljunid	13.12.59	Machang/ Tanah Merah	13.12.59
Syed Nordin Jasmani bin Sy. Othman	16.11.59	Taiping	16.11.59
Yusof bin Ismail	16.11.59	Machang	16.11.59
Zaharom bin Abd. Rashid	16.11.59	Seremban	16.11.59
Chew Fook Khuan	16.11.59	Ayer Tawar	16.11.59
Goh Hee Kooi	16.11.59	Sg. Patani	16.11.59
Huang Heng Shu	16.11.59	Kajang	16.11.59
Lee Hein Lyn	16.11.59	Sg. Patani	16.11.59
Ng Kim Foh	16.11.59	Seremban	16.11.59
Su Tuang Ping	16.11.59	Sitiawan	16.11.59
Tan Aik Hong	16.11.59	Batu Pahat	16.11.59
Tan Teik Peow	16.11.59	Taiping	16.11.59
Wong Tang Kah	16.11.59	Seremban	16.11.59
Wong Tee Kia	16.11.59	Segamat	16.11.59
Wong Yook Foo	16.11.59	Ipoh	16.11.59

Resignations 1959

Jaafar bin Mohamed	13. 8.59	
		(Long leave 1.8.59 to 31.10.59)
Abdullah bin Hj. Hashim	1.11.59	
Tan Kim Chooi	21.11.59	
Mong Sek Kheong	7. 8.59	
Chan Yong Sang	26.11.59	
Ling Ah Song	28. 7.59	Dismissed
Dzulkifli b. Hj. Bahaman	22.12.59	
Lim Ah San	1.11.59	

Long Leave 1959

Abu Bakar bin Mohd Yassin	4. 8..59 to 3.11.59
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Rubber Demonstrators

Ghazali bin Jamaluddin	1.12.53	Baling	1.12.53
Haron bin Haji Yassin	7.10.50	Ayer Hitam	7.10.50
Ismail bin Haji Ahmad	1. 4.46	Kuala Krai	1. 4.46
Mohd Jam bin Abd. Manan	10.11.46	Dong	10.11.45
Mohd Yunus bin Awang	16. 8.52	Tanah Merah	16. 8.52
Salleh bin Mohamad	1. 7.52	Kuala Brang	1. 7.52
Wan Hussein bin Wan Choh	1. 6.52	Kangar	1. 6.52
Yaacob bin Dom	2. 1.58	Gual Periok	2. 1.58
Yusof bin Sulaiman (Boatman)	1. 7.56	Kuala Krai	1. 7.56
Tan Per	16.12.49	Muar	16.12.49
Teh Ho Yeow	8. 2.49	Taiping	8. 2.49

Estates Advisory Service

In this, the first complete year of independent operation, the development of the Estates Advisory Service has been severely restricted by shortage of staff.

The Head of the Service (Mr L. R. Davidson) was on duty throughout the year. Mr Lim Poh Loh was appointed Assistant Advisory Officer and assumed duty on 6 April.

Scope of the Service

The activities of the Service have been adjusted to the staff available and work attempted falls under the following heads: the advisory work of the Soils Division for estates; assistance to Pathological and Botanical Divisions, wherever consultations required by estates can be fitted into our travelling programmes; and extension of the Institute's assistance to the smaller categories of proprietary estates.

The Estates Advisory Service has thus dealt with problems touching on all the main agronomic aspects of rubber production, as shown by the analysis in the Table below. The research Divisions have given assistance whenever necessary in the form of laboratory investigations and advice from specialist research officers.

The effort to extend the influence of the Institute to proprietary estates was limited, in 1959, to estates in Chinese ownership. Mr Lim commenced a survey of a 10% random sample of all Chinese-owned rubber estates of up to 1,000 acres. This survey has two objects: to obtain data to assist staff in planning the development of advisory work and to spread information on the services available to rubber growers.

No special steps were taken to increase work on Indian-owned estates, but the R.R.I.M. has always received a certain number of enquiries from estates in this category. There was a small, but definite increase in these enquiries during the second half of the year.

The analysis in the Table shows the important part played by estate visits.

ANALYSIS OF CORRESPONDENCE AND REPORTS ON VISITS

Subject	Letters		Items covered in reports on visits
	Received	Despatched	
Planting operations and maintenance	25	26	75
Manuring	65	60	94
Covers and control of weeds	73	68	44
Planting material	35	36	46
Tapping and stimulation	8	15	36
Wind damage	6	3	2
Diseases, pests and injuries	14	16	39
Reports on visits	—	174	—
Survey	12	113	—
Non-technical	262	357	—
	500	868	

Estates Advisory Service

The third column of figures shows the number of subjects, classified under seven broad headings, on which advice has been given as a result of visits. In all, 192 advisory visits were made to estates, but a limited number were visited more than once during the year so that the actual number of estates which received one or more visits is 173. Visits are further analysed in the Tables below by type of ownership and by geographical location, to show the distribution of our work in relation to requirements suggested by available statistics.

ANALYSIS OF VISITS BY TYPE OF OWNERSHIP

Type of ownership	Visits	Estate Statistics*	
		No. of estates	Total acreage of group, '000 acres
Overseas			
Mainly European	63	565	1,254
Malayan			
Chinese	107	} 1,837	735
Indian	21		
Malay	1		

* Extracted from *Rubber Statistics Handbook* 1958.

About 66% of the effort was devoted to the Malayan-owned estates, representing 37% of the estate rubber area. This is considered to be justified by the smaller size of the plantations of these producers (there are three times as many units), their relative lack of knowledge of technical developments and the importance of personal contact in achieving results. It should also be appreciated that European-owned estates obtain a large part of their technical information by means of correspondence and the major proportion of letters giving technical information have been addressed to European company-owned estates. Visits by specialist officers have, in the main, been to the same category of estate. There therefore remains considerable scope for increasing the effort to provide information and assistance to the proprietary Malayan-owned estates.

ANALYSIS OF VISITS BY GEOGRAPHICAL LOCATION

Territory	Visits	Estate Statistics*	
		No. of estates	Rubber, '000 acres
Kedah and Perlis	10	261	217
Penang and P.W.	13	61	31
Perak	32	393	278
Pahang	16	191	113
Selangor	31	354	339
Negri Sembilan	35	314	277
Malacca	16	153	120
Johore	39	548	545
Kelantan	0	56	42
Trengganu	0	40	18

* Extracted from *Rubber Statistics Handbook* 1958.

Visits to estates in different territories, as shown in the table above, were roughly in proportion to the number of estates in those territories with a few notable exceptions. In Penang and Province Wellesley, the proportion of visits appears to be high and this may be explained by the fact that this territory has been more heavily affected by fragmentation than others and the number of units has increased considerably since the 1958 statistics were compiled. In addition, our survey of Chinese-owned estates commenced in that territory and, as a consequence, information on the service available may have reached a wider circle of planters there than elsewhere. Kelantan and Trengganu have had no visits at all and Kedah and Perlis probably less than their fair share. Steps are being taken to remedy these defects as early as possible in 1960.

Planting Operations and Maintenance

Under this heading are classified all problems concerned with the planning and execution of planting operations, clearing of land, provision of earthworks and drainage and all maintenance work not otherwise separately listed. The heading also includes planting density and thinning operations.

Disposing of the old stand before replanting and planting density were the aspects on which advice was most commonly required. An equally important problem which is commonly unrecognised is the need for systematic thinning of the stand up to and beyond the time of opening for tapping. It is clear that among the majority of proprietary planters the influence of stand on growth is not fully appreciated and a consistent effort is required to bring home the importance of this subject.

Manuring

Advice on manuring was concentrated on the manuring of young rubber. The need for visits arises most frequently in the case of recently planted areas and in such cases it is a considerable advantage if the Advisory Service is given early notice that advice will be needed on the manuring of young plantings.

For mature rubber, recommendations have been summarised in our publications to cover a few broad categories of conditions which are normally distinguishable by managers, visiting agents and the advisory services provided by fertiliser firms. In these circumstances, visits by Advisory Officers of the Institute to the estates are not required. A large number of visits have been sought, however, to confirm manuring programmes for young rubber in tapping. More difficult problems arise in connection with manuring to maintain the yields of improved rubber planted before the war. It is particularly difficult to decide whether or not to manure trees which have deteriorated considerably but are important for maintenance of production while older rubber is being replanted.

Deficiencies of magnesium and manganese required a considerable amount of attention in immature and young areas in tapping. The former is now readily recognised by planters in most cases and the corrective treatment is well known. A small amount of magnesium sulphate (2% MgO) is now included in a high proportion of standard mixtures and these are sometimes used as an insurance against the possibility of deficiency. Pending further information from investigations in the Soils and Chemical divisions on the part played by magnesium in the growth of rubber trees and the behaviour of latex, the policy of the Advisory

Service is to recommend the use of magnesium as a fertiliser only when deficiency is established or appears likely to develop.

Manganese deficiency was identified on nine estates visited. Five of these are in the southern half of Johore and the others in northern Selangor and Perak. All were on soils of low fertility, sometimes with a history of intensive cultivation. In one case, the deficiency symptoms developed only after manuring with major nutrient elements had been increased on our recommendation. All cases will be kept under observation to assist in establishing economical and effective treatment.

Cover Plants and Control of Weeds

Under this heading we have included all problems of establishment and maintenance of ground covers, including destruction of unwanted species and control of pests and diseases of the useful cover plants. The frequent lack of certainty on the part of planters in classifying these problems as pathological or nutritional makes the benefits of a unified Advisory Service particularly apparent. Once the nature of a particular problem has been clarified, the Advisory Service is in a position to consult specialist officers in the Research Divisions when necessary.

With the larger company-owned estates the commonest problems concern identification and treatment of pests, diseases and nutrient deficiencies in leguminous covers and selective control of undesirable plants. On the smaller estates our advice is primarily needed on problems of establishment of legumes and elimination of grasses. Throughout the industry there is, however, a certain degree of uncertainty on the most economic management of ground covers. The Institute requires further reliable information on management costs to determine the most efficient systems of management for different conditions.

Eradication of lalang (*Imperata cylindrica*) remains an essential preliminary to replanting on many proprietary estates. Dalapon (2,2-dichloropropionic acid) has provided a satisfactory solution to problems of control in many cases.

Planting Material

Advice on this subject has generally been given following visits to assess the suitability of clones for particular conditions of soil and topography. For the smaller estates, advice on choice of material has generally to be supplemented by detailed instructions for establishment of nurseries, time-tables for planting operations and quantities of material required for propagation. It is important that estates with such problems should seek assistance in good time.

Tapping and Stimulation

In this field our work has been mainly confined to the smaller estates on which it has frequently been necessary to emphasise the need for reduction of intensity of tapping of clonal seedlings from S/2.d/2.100% to S/2.d/3.67%. On some properties, past histories of high rates of bark excision and irregular sequence of panels complicates and limits the full exploitation of older trees. Such histories may explain some of the disappointment expressed at the results of application of yield stimulants. Whatever the reason, many estates remain hesitant about the use of such materials. Undoubtedly there have been frequent cases of excessive application and failure to complete tapping of stimulated bark. In addition, preliminary scraping may sometimes be at fault. An attempt is being made to correct

such errors by careful demonstration of the technique wherever the use of stimulants is recommended. It is, however, more difficult to counteract another common source of faulty assessment of the merits of yield stimulants, namely, failure to record and keep in mind the general level of pre-treatment yield. With the inevitable fluctuations of production following bi-annual applications, the depressions are too commonly compared with the peaks which follow stimulation instead of with the pre-treatment yields.

Diseases, Pests and Injuries

Much of the advice on diseases and pests involves reassuring owners or managers that the conditions noted are non-pathogenic in origin, in which case the estate may be saved unnecessary expenditure. A regular features of visits to smaller estates with immature or young rubber in tapping is that careful instruction on treatment of root disease and pink disease must be provided. To be effective, such instruction must be given at foreman or labourer level. There may be more demand in the future for the type of service which the Pathological division provides in training estate labour gangs in root disease control.

Survey of Chinese-owned Estates of 1,000 Acres or Less

In May, Mr Lim Poh Loh commenced a survey of estates of 1,000 acres or less, in Chinese ownership. A 10% random sample of estates in each territory was made, using the lists of estates provided by the Department of Statistics. We are indebted to Mr H. A. Fell, at that time Chief Statistician, for assistance in initiating the work. At the end of the year, interviewing and recording of information had been done for 105 estates. The survey was completed in Province Wellesley (8 samples), Selangor (16 samples), Negri Sembilan (17 samples), Malacca (10 samples) and Johore (33 samples). A start had been made in Perak (12 samples) and Pahang (9 samples) and will be continued in these states and in Kedah.

As a measure of the previous contact of these estates with the R.R.I.M., only 25% of those investigated were on our mailing lists for *Planters' Bulletin*. The importance of language is shown by the fact that 61% of all owners and 77% of all managers would prefer to receive publications in the Chinese language.

The need for the Chinese language in personal contact with owners and managers is approximately the same as for publications, although knowledge of spoken Malay or English allows for greater flexibility in this respect. Only 52% require correspondence in Chinese.

In our survey we have given special attention to the recording of the areas under mature high yielding rubber and immature rubber as general measures of the level of progressiveness on individual estates. In view of the need for replanting with high yielding material, it is a matter for concern that on 62% of estates comprising 54% of the total acreage there is no mature high yielding rubber, while immature rubber is absent from 50% of estates comprising 43% of the total acreage. These figures indicate the scope for improvement in efficiency and productivity.

Future Programme

1959 has been a year of initiation of work with limited staff and of collecting data as a basis for calculations of future development. From the knowledge

gained to date, we propose a total staff of six advisory officers (including the Head of the Service) of whom two should be fluent in the Chinese dialects and one in Tamil.

With this staff, we should be able to maintain the level of advice previously given by the Soils, Botanical, and Pathological Divisions to the large company-owned estates. It is likely that some increase will in fact take place owing to the readier availability of officers undertaking frequent tours and dealing with problems throughout the agronomic field. Our principal aim will be to extend the influence of the R.R.I.M. on the smaller estates between 100 and 1,000 acres. These are recorded as numbering 1,835 comprising 519,761 acres of rubber*. Approximately two-thirds of these estates are in Chinese ownership and the general structure and requirements for advice are covered by the data from our survey reported briefly above. We have more limited knowledge of the Indian-owned estates, but it is judged that they make up the greater part of the remaining third of estates of up to 1,000 acres. When the staff position permits, we shall undertake a sample survey of these estates.

Broadly, the need is clear to have staff available to visit estates and persuade owners and managers to adopt well-proved methods of increasing productivity and efficiency. The work of the Advisory Service will be initially concentrated on those improvements which give rapid and readily assessable results, such as systematic exploitation of older rubber, correct use of yield stimulants and fertilisers and control of ground covers. Ultimately, the aim must be to increase the area planted with high yielding material and to ensure that it is developed and maintained to secure profitable production under changing conditions of prices and costs.

Personal contact is the most costly as well as the most effective method of giving technical advice. In the interests of overall economy it must be supplemented by printed matter to the fullest extent practicable. The need for publications in Chinese is being catered for by the Publications Section with plans for a quarterly *Planters' Bulletin* in Chinese. We do not yet have information to justify the printing of a Bulletin in Tamil but there is an undoubted need for printed or duplicated instructions in this language.

The foregoing proposals are based on present assessment of relatively limited data and operation of the service adds continually to our experience and knowledge of requirements of various classes of planters. It is of first importance that a large measure of flexibility should be retained in the organisation of the Estates Advisory Service so that changes can be made as required to take advantage of new knowledge and experience.

L. R. DAVIDSON
Head of Estates Advisory Service

* Rubber Statistics Handbook 1958.

Publications and Information

The post of Publications Officer was filled in January when Mr W. J. Baulkwill took charge of the Section. In April, Mr A. G. Parker, Librarian of the British Rubber Producers' Research Association, was seconded to the Institute to re-organise the library. The process of reorganisation will cover a period of two years. Mr J. S. Soosai was appointed Librarian designate during the year and began special library training course at the North Western Polytechnic, London. He will take charge of the library on Mr Parker's return to the B.R.P.R.A. in 1961.

Publications

Annual Report. The publication of the *Annual Report* was brought up to date with the preparation of the *Annual Report 1958* during the year.

Journal. Volume 15 of the *Journal of the Rubber Research Institute of Malaya* was completed by the issue of Part V. Part I of Volume 16 was issued towards the end of the year. Work was started on bringing the indexes of the *Journal* up to date; this includes the preparation of a Subject Index for Volumes 1–12 and for Volumes 13, 14 and 15. Further cumulative 4-volume indexes are planned, to be issued on completion of Volume 16 and at the completion of each successive four volumes.

Planters' Bulletin. Publication of *Planters' Bulletin* continued and plans were made for the publication of indexes as follows: (a) yearly subject index; (b) a cumulative subject index for numbers 1–14, 1952–59, to be issued in 1960; (c) cumulative subject indexes at intervals of 2 and 4 years, beginning with a 2-year index in 1961.

In preparation for the eventual publication of *Planters' Bulletin* in Malay and Chinese, a survey was made, through the Smallholders' Advisory Service, of the demand for this publication in Malay (Rumi and Jawi) and Chinese in each State in Malaya. As a result of this survey the immediate demand for *Planters' Bulletin* in these languages was estimated as: Malay (Rumi) 2000; Malay (Jawi) 3000; Chinese 2000. A survey made by the Estates Advisory Service of estates of 100–1000 acres showed a potential demand by these estates for a further 1000 copies of the Chinese version.

Miscellaneous Publications. Numerous advisory leaflets were issued or re-issued during the year. Two further documents were added to the *Research Archives of the Rubber Research Institute of Malaya* and cyclostyled in sufficient numbers to be made available on request. Several papers were contributed to outside journals during the year. All publications during 1959 are listed in the reports of the Divisions responsible for them.

Maladies of Hevea in Malaya by R. N. Hilton, illustrated by Hoh Choo Chuan, was published, having previously been prepared for printing by Pathological Division; 1070 copies were sold during the year and 289 complimentary copies were distributed.

Library

The work of reorganising the library was started on Mr Parker's arrival in April.

Attention was first paid to rehousing the library stock in reconstructed accommodation. The planning of the physical aspects of the new library occupied substantial periods of time for the rest of the year and orders were ready for placing in December.

Reclassification and cataloguing of the bookstock was begun. The compilation of a list of the library's holdings of journals was completed by Christmas, after about four months of intermittent work.

At the same time the efficiency of the routine services and operations of the library was examined.

W. J. BAULKWILL
Publications Officer

R.R.I. Experiment Station

Mr. A. E. Browne resigned from the post of deputy manager on 1 July. Mr J. D. Macritchie, assistant manager, returned from home leave on 12 August and Mr J. H. Chapman, the other assistant manager, went on home leave on 19 August. Mr C. Y. Ross was appointed assistant manager on 23 October. Mr G. A. Gilbertson was appointed resident engineer on 18 May. The manager was on duty throughout the year. Two members of the junior staff took long leave during the year.

Training courses. The following courses were held on the station:

Three courses of five days for thirty-seven Senior Estate Conductors.

Two courses each of about two-and-a-half months duration for sixty prospective Junior Rubber Instructors.

One refresher course of eighteen days for twenty-eight Junior Replanting Inspectors (R.I.R.B.).

One course of eighteen days for seventeen Field Officers from the Department of Agriculture, Sarawak.

One course of one month's duration for twenty-eight Kampong Youths.

Visitors. There were 734 visitors to the station during the year.

Health. The health of the labour force and staff resident on the station was generally good. There were fifty-four births and four deaths. Eighty-two cases were admitted to hospital and 1406 minor cases were treated locally.

Acreage. Details of the acreage statement at 31 December were:

							<i>Acres</i>
Mature rubber in tapping ...	...	...	...	...	...	...	1,393.75
Immature rubber ...	...	...	...	...	...	...	1,316.00
Nurseries ...	...	...	...	...	...	...	51.75
Building site and roads ...	...	...	...	...	...	...	106.25
Reserve land, swamp etc. ...	...	...	...	...	...	...	111.25
							2,979.00

Rainfall. Total rainfall was 124.17 in. Rain fell on 197 days.

<i>Month</i>	<i>Rainfall, in.</i>	<i>Period, days</i>	<i>Month</i>	<i>Rainfall, in.</i>	<i>Period, days</i>
January	5.93	13	July	8.78	9
February	7.18	14	August	4.82	14
March	10.19	21	September	14.93	17
April	18.75	21	October	20.86	22
May	8.11	17	November	10.18	22
June	6.47	12	December	7.97	15

NEW PLANTING AND REPLANTING

New Planting

The 214½ acres of jungle land which were felled at the end of 1958 were burned off in February. The clearing was terraced and planted with germinated seed in October and November.

This completes the clearing and planting of all available reserve land on the station. The clearing has been allocated for three manurial trials, a large scale clone trial and a small scale clone trial.

Throughout the area, a cover of *Centrosema pubescens* and *Calopogonium mucunoides* was planted and these legumes are now growing in association with selected natural covers.

Replanting

Field 19 (48 acres). The trees in the old rubber area south of the Sungei Pelan were uprooted and the field was re-terraced and planted with germinated seed. An experiment to test cover crops, manurial treatments and weeding methods has been laid out over most of this area.

On the flat land north of the Sungei Pelan, the old rubber was felled at the collar and the stumps were poisoned. The existing cover under the old rubber, predominantly grasses, has been retained and is used as a trial area for testing new herbicides.

Field 15. Five acres of rubber at the north end of this field were felled and the land was prepared and planted up as an extension to the budwood nurseries.

IMMATURE AREAS

Budgrafting

Field 62C (36 acres). This field was budded with 443 new clones made from the 1957 hand-pollinated seedlings.

The small scale trial was laid out in the normal way with two plots of six trees of each clone.

Field 63C (43 acres). The manurial trial and discard sections which were budded with clones LCB 1320, GT 1 and PB 86 at the end of 1958 were cut back at the beginning of the year.

Field 60F (Crown budding experiment). Supply budding with the appropriate *Dothidella*-resistant clones was carried out throughout the year.

Manuring

Fertilisers were applied to 1,199¼ acres of immature rubber (excluding manuring experiments) as detailed below:

Field	Acres	Rate per tree	Fertiliser
6	41.50	8 + 12 oz 4 + 4 oz (additional on some plots)	Mixture Magnesium X Sulphate of ammonia Mixture Magnesium X
16N*	5.00	32 oz	„ „ X
16N(Boundary)	4.25	8 + 12 oz	„ „ X
17	34.50	4 + 6 + 6 oz	„ „ X

* Hand-pollinated seedlings

<i>Field</i>	<i>Acres</i>	<i>Rate per tree</i>	<i>Fertiliser</i>
19 (non-exptl)	38.00	{ 4 oz 4 oz	Rock phosphate ** Mixture M
23	62.00	6 + 8 oz	Mixture Magnesium X ***
24	32.00	8 + 12 oz	" " C2
37	5.00	32 oz	" " X
52	54.00	2 lb	Mixture B
53	48.00	2 lb	" B
54 (discard)	32.00	2 lb	Special Mixture
55	49.25	2 lb	Mixture D
56	51.50	2 lb	" D
57	40.00	2 lb	" D
58	75.00	2 lb	" D
60	257.00	1½ lb	" M(hill) and D
61	84.00	8 oz	" M
62, 63	115.00	6 oz	" M
64	144.25	{ 4 oz 4 oz	Rock phosphate ** Mixture M
65	27.00	{ 4 oz 4 oz	Rock phosphate Mixture M

Covers in the following fields received fertiliser dressings as shown:

<i>Field</i>	<i>Acres</i>	<i>Fertiliser application per acre</i>
6 41.50		1 cwt rock phosphate Plots 102, 104, 106, 108 and 110 received an additional 2 cwt of rock phosphate.
23 (Botany cover expt)	28.75	1 cwt rock phosphate
23 (discard) 33.00		1 cwt basic slag
24 32.25		1 cwt rock phosphate
17 34.50		{ 1 cwt rock phosphate 2 $\frac{3}{4}$ cwt basic slag 1 cwt Mixture Magnesium X
19 (non expt) 38.00		$\frac{1}{2}$ cwt rock phosphate
61 84.00		1 cwt rock phosphate
62, 63A 85.00		1 cwt rock phosphate
64, 65A/C 183.75		$\frac{3}{4}$ cwt rock phosphate

Thinning Out

Field 16N. Boundary. The stand was reduced to 140 trees per acre.

Field 48D. The stand was reduced to 125 trees per acre.

Field 52B/E. The stand was reduced to 147 trees per acre (65 trees per plot).

** applied to planting hole

*** applied to individual plants

Field 54. The stand was reduced to 140 trees per acre.

Field 55B. The stand was reduced to 161 trees per acre (10 trees per plot).

Field 58C. The stand was reduced to 160 trees per acre (70 trees per plot).

Field 60B. The stand was reduced to 152 trees per acre (38 trees per plot).

Field 60E. The stand was reduced to 150 trees per acre.

Seed garden D (RRIM 600 series hedge trial). The stand was reduced to 100 trees per acre (23 trees per plot).

Supplying

Budded stumps of the appropriate clones were supplied to vacancies in Fields 23, 24 and 63C.

Two rounds of supplying crown budded stumps in Field 60F, (crown budding experiment) were completed.

Pests and Diseases

Root disease. A new system of diagnosis of disease from routine quarterly foliage inspection was introduced at the beginning of the year instead of the collar inspection method which had been practised hitherto.

1,090½ acres of immature rubber were under this method of control during the year.

Area inspected Cases	New planting 916 acres		Replanting 174½ acres		Total no. cases
	Treated	Removed	Treated	Removed	
<i>Fomes lignosus</i>	180	201	226	225	832
<i>Ganoderma pseudoferreum</i>	22	55	2	24	103
<i>Fomes noxius</i>	13	73	—	11	97
<i>Ustulina zonata</i>	4	12	—	—	16
	219	341	228	260	1,048

Pink disease. Regular rounds of inspection and treatment were maintained throughout the immature area. A total of 10,600 cases (including recurrent cases) were treated on 776 acres under regular inspection.

Termites. A prophylactic application of two pints of Aldrex (dilution 1:400) was given to all trees in Fields 6, 52, 53, 54, 55, 56, 57, 60 (swamp area), 62 and 63. The total area treated was 632¾ acres.

Storm damage. 1,478 cases were pruned; 910 fallen trees were cleared.

General Maintenance of Immature Areas

There was no change in the policy of maintenance in immature areas. Young rubber was strip-weeded manually up to the fifth calendar year and thereafter received regular rounds of chemical spray weeding along the planting rows. Selected natural covers are growing with leguminous creepers throughout most of the immature area. Natural covers were kept slashed to a height of three feet.

MATURE AREA

The system of maintenance and upkeep of mature rubber remained unchanged.

Manuring

The following fields received fertiliser applications:

Field 33A (4.75 acres) received $4\frac{1}{2}$ lb per tree of Mixture B

Field 48 (149 acres) received 4 lb per tree of Mixture B

Field 51 (63 acres) received 4 lb per tree of Mixture D

Seed gardens A,C,D 1 and 2 (134 acres) received 4 lb per tree of Mixture Magnesium Y.

Pests and Disease

Root disease. 305.5 acres of young mature rubber were under periodic foliage inspection during the year. In addition, sundry cases were treated in the old rubber. A total of 81 trees were removed and 106 cases treated.

Termites. A total of 1,176 trees were treated and 97 trees were removed.

Pink disease. 1,190 cases were treated.

Storm damage. 1,325 cases were pruned and 837 fallen trees were cleared.

Tapping

The following fields were brought into tapping during the year:

Location

Field 51C	...	...	...	...	...	17.25	acres	on	January 1
Field 51D	...	...	...	...	...	13.50	..	..	..
Field 52C	...	...	...	...	...	1.00	..	..	..
Seed gardens C and D3	...	...	...	...	...	47.75	..	..	..
Field 47 (A and B plots and discard)	...	...	...	...	...	21.00	..	..	April 1
Field 53 (A and D plots and boundaries)	...	...	...	...	...	13.25	..	..	July 1
Field 54	...	...	...	...	...	59.75	..	..	..
Field 16N (H.P. seedlings)	...	...	...	...	...	5.75	..	..	October 1

Intensive tapping. The following fields were under 200% intensive tapping for various periods during the year:

Field	Acreage	Period, months	Field	Acreage	Period, months
2	15.50	1	15A.E.	5.00	2
4A	10.00	1	16 (S)	10.25	11
14A/B	37.75	12	19	59.00	3
14C/D	32.00	10	20B	19.25	1
14E1	8.00	10	23A	10.25	6
15	5.00	12	42 (W)	9.00	1

The above fields are either scheduled for replanting in the near future or were replanted during 1959.

Yield stimulation. Yield stimulants (non-experimental) were applied over 145 acres, chiefly on the high cuts of areas under 200% intensive tapping.

R.R.I. Experiment Station

Crop

The crop for the year averaged just over 1,000 lb per acre. Monthly figures are given below:

					<i>Acreage tapped</i>	<i>Total crop, lb</i>	<i>lb per acre</i>
January	...	...	...	...	1,363.00	131,326	96.35
February	...	...	...	...	1,321.00	106,835	80.87
March	...	...	...	...	1,299.00	96,773	74.50
April	...	...	...	...	1,320.00	89,860	68.08
May	...	...	...	...	1,320.00	112,008	84.85
June	...	...	...	...	1,320.00	115,066	87.17
July	...	...	...	...	1,388.00	118,863	85.64
August	...	...	...	...	1,388.00	109,489	78.88
September	...	...	...	...	1,388.00	116,146	83.68
October	...	...	...	...	1,393.75	108,882	78.12
November	...	...	...	...	1,393.75	130,505	93.64
December	...	...	...	...	1,393.75	135,931	97.53
						1,371,684	1,009.31

During the year there were 310 days normal tapping, 33 days late tapping, 12 days rain (no tapping), 10 days holiday (no tapping).

Manufacture

The following grades of rubber were manufactured:

RSS	...	...	...	...	...	...	249,583 lb
SPRSS	...	...	...	...	...	...	69,109 "
Latex concentrate d.r.c.	...	...	...	...	...	...	580,779 "
SP crepe	...	...	...	...	...	...	9,665 "
SP brown crepe	...	...	...	...	...	...	50,140 "
Lower grade crepes	...	...	...	...	...	...	276,304 "
Skim crepe	...	...	...	...	...	...	51,445 "

Unmanufactured

Cup samples	...	...	...	...	...	...	80,495 "
Scrap	...	...	...	...	...	...	4,164 "
						1,371,684 lb	

Seed Gardens and Multiplication Nurseries

All ground covers in the Seed Gardens were kept sprayed with sodium arsenite during the seed fall.

A total of 634,839 seeds were collected, most of which were despatched to the Department of Agriculture for smallholders.

9,101 yards of budwood, chiefly of the RRIM 600 series clones, were supplied to estates and smallholdings.

EXPERIMENTAL

Further details of work under this heading are contained in the reports of the Divisions concerned.

Recording

Yield recording in experimental areas continued to be by the cup coagulation method.

Girth, height and bark measurements were taken in most experimental areas.

Manurial Trials

Manuring experiments in Fields 15, 23, 31, 47, 54, 63B, 63C and 63D and Seed Gardens B and D received fertiliser applications. New experiments were started in Fields 19, 65A and 65B.

Cover Crop Trials

Cover trials in Fields 6, 17, 23, 24 and 63A were maintained throughout the year.

Spraying Trials

A number of small scale spraying trials were carried out with various chemical solutions on grasses and other weeds.

Tapping and Yield Stimulation Experiments

Tapping experiments in Fields 5, 21 and 22 were continued. A number of short term yield stimulation experiments were carried out in addition to the main experiments in Fields 5 (boundary), 14E1, 16(S) and 33.

Clone Trials

Yields from large scale clone trials in Fields 30, 38, 48A/D and Seed Garden D were recorded throughout the year.

Small scale clone trials in Fields 48B/E, 49, 51 as well as selected clones in Fields 32, 33, 34, 38 and 45 were also under individual clone recording.

Hand Pollination

A total of 30,411 pollinations were made. 2,246 fruits were harvested. 4,616 germinated seeds were planted in large baskets and later planted out 4 × 4 ft in a special nursery.

BUILDING, PLANT AND MACHINERY

The building site was extended on the eastern side by felling fifteen acres of rubber in Field 2.

Fourteen units of semi-detached junior staff quarters, a twelve-bed hostel and eight rooms of labour lines were built on this site.

The old junior staff bachelor quarters were demolished and two units of semi-detached junior staff quarters were erected on the same site.

New laboratories for the Botanical Division were built close to the Chemical Division laboratories.

The packing shed was extended to give double the storage capacity.

R.R.I. Experiment Station

A set of old five-room lines near the office, which accommodated drivers, was converted to garages.

At the end of the year, a new Type B tunnel smoke house was under construction to replace the old Types A and C smoke houses.

The crepe drying tunnel was modified by the installation of a heat exchange unit in place of steam drying.

The drying truck railway from the factory to all drying sheds and the packing shed was relaid on a broader gauge suitable particularly for the Type B smoke house.

Electricity

The overhead mains throughout the station were renewed, all wooden poles were replaced by reinforced concrete poles and a new switchboard was installed in the power house. In addition, a considerable amount of service wiring to buildings was renewed.

Water Supply

A reinforced concrete storage tank of 100,000 gallons capacity was built near the filtration plant. An additional diesel pumping station was set up in Field 17 and connected to the existing pumping station in Field 22 with a six-inch pipe line.

Machinery

A new scrap washer and creping battery were installed in the factory.

The old creping battery received a major overhaul. All other machinery worked satisfactorily throughout the year.

LABOUR

There was an ample supply of labour. The labour strength on 31 December was:

<i>On check roll</i>						<i>Men</i>	<i>Women</i>	<i>Children</i>	<i>Total</i>
Indians	...	...	...	...	...	215	183	37	435
Malays	...	...	...	...	...	13	—	—	13
Total on check roll						228	183	37	448
<i>On contract</i>									
Malays	...	...	...	...	...	23	6	—	29
Chinese	...	...	...	...	...	1	3	—	4
Total workers						252	192	37	481
Dependants (Indians)						14	20	387	421

R. F. HARLEY

Manager

R.R.I. Experiment Station

SENIOR STAFF*

ADMINISTRATION

- C. E. T. Mann, M.Sc., F.I.R.I., *Director*. (15 June 1927)
 C. G. Akhurst, B.Sc., A.R.C.S., A.I.C.T.A., *Deputy Director*. (7 October 1930)
 H. S. Blacklin, *Secretary*. (1 March 1932) Retired 15 March 1959.
 J. C. Reeves, F.C.C.S., *Secretary*. (11 September 1950)
 H. F. Logan, *Assistant Secretary*. (12 January 1959)
 J. A. Faulkner, *Maintenance Engineer*. (1 November 1955)

PUBLICATIONS AND INFORMATION SECTION

- W. J. Baulkwill, B.A., N.D.A., *Publications and Information Officer* (6 January 1959)
 A. G. Parker, A.L.A., A.I.L., *Librarian*. (20 April 1959) Seconded from B.R.P.R.A.

STATISTICS DIVISION

- D. R. Westgarth, M.Sc., *Head of Division*. (19 November 1959)
 A. Fong Chu Chai, B.Sc., Dip. Arts, *Statistician*. (8 July 1949)
 G. Chidambara Iyer, M.Sc., *Assistant Statistician*. (20 August 1955)

EXPERIMENT STATION

- R. F. Harley, M.C., F.I.S.P., *Manager*. (27 August 1937)
 A. E. Browne, M.C., *Deputy Manager*. (1 February 1948) Resigned 30 June 1959.
 J. D. Macritchie, B.Sc., (Agri.), *Assistant Manager*. (15 December 1954)
 J. H. Chapman, B.Sc., (Agric.), *Assistant Manager*. (19 August 1955)
 C. Y. Ross, *Assistant Manager*. (23 October 1959)
 G. A. Gilbertson, *Resident Engineer*. (18 May 1959)

SOILS DIVISION

- G. Owen, M.Sc., F.I.S.P., *Head of Division*. (5 January 1939)
 G. A. Watson, M.Sc., Ph.D., A.R.C.S., D.I.C., A.R.I.C., *Soils Chemist*. (17 November 1955)
 V. M. Shorrocks, M.A., D.Phil., M.I. Biol., *Plant Physiologist*. (28 August 1957)
 K. R. Middleton, M.Sc., A.R.I.C., *Soils Chemist*. (16 October 1958)

* The date of first appointment of members of the staff is given in brackets after each name.

- J. Bolton, B.Sc., A.R.I.C., *Agronomist*. (25 October 1958)
 M. M. Guha, B.Sc., Assoc. I.A.R.I., *Assistant Soils Chemist*. (20 May 1955) On study course in Scotland.
 K. Raman, M.Sc., Ph.D., *Assistant Soils Chemist*. (23 April 1958).

BOTANICAL DIVISION

- C. W. Brookson, B.Sc., *Head of Division*. (23 August 1949)
 P. de Jonge, I.I., *Botanist*. (29 December 1950)
 P. R. Wycherley, Ph.D., *Botanist*. (26 January 1953)
 J. M. Ross, B.Sc., *Botanist*. (5 December 1955)
 S. G. Boatman, Ph.D., *Botanist*. (2 November 1956)
 J. K. Templeton, M. Agr. Sc., D. Phil., *Botanist*. (24 January 1958)
 E. C. Paardekooper, I.I., *Botanist*. (23 June 1958)
 G. H. Tinley, M.Sc., *Botanist*. (26 November 1958)
 B. R. Buttery, Ph.D., *Botanist*. (18 August 1959)
 T. V. Vaidyanathan, B. Agric., *Assistant Botanist*. (1 May 1935)
 M. M. Chandapilla, B.Sc., *Assistant Botanist*. (2 January 1958)
 P. D. Abraham, B.Sc., (Agric.) *Assistant Botanist*. (13 October 1958)

PATHOLOGICAL DIVISION

- A. Newsam, Ph.D., *Head of Division*. (5 April 1947)
 F. W. Hutchison, N.D.A., C.D.A., *Field Research Officer*. (5 March 1948)
 R. N. Hilton, M.A., *Pathologist*. (7 September 1948)
 R. A. Fox, B.Sc., B. Agr., *Microbiologist*. (2 March 1954)
 K. P. John, B.A., *Assistant Pathologist*. (16 November 1936)
 B. S. Rao, M.A., *Assistant Entomologist*. (6 June 1952)

CHEMICAL DIVISION

- W. G. Wren, B.Sc., A.R.C.S., D.I.C., A.I.R.I., *Head of Division*. (7 January 1950)
 G. W. Drake, B.Sc., M.A., *Chemist*. (8 March 1948)
 W. A. Southorn, Ph.D., A.R.I.C., *Chemist*. (18 November 1952)
 J. E. Morris, B.Sc., A.R.I.C., *Chemist*. (20 June 1952)
 R. S. Gale, B.Sc., A.C.G.I., A.M.I. Chem. E., *Chemical Engineer*. (2 May 1951)
 D. J. Graham, A.S.T.C., A.R.A.C.I., *Chemical Engineer*. (31 March 1953)
 D. H. Taysum, M.Sc., D.I.C., *Microbiologist*. (13 September 1954)
 G. F. J. Moir, B.Sc., *Biochemist*. (2 February 1955)
 B. C. Sekhar, B.Sc., M.S., A.R.I.C., A.I.R.I., *Chemist*. (15 September 1949)
 C. A. K. Salgado, B.Sc., *Technologist*. (22 April 1957)
 F. W. Shipley, Ph.D., *Chemist*. (6 August 1958) Seconded from B.R.P.R.A.

T. V. Molesworth, B.Sc., (Tech.), A.M.I. Chem. E., *Chemical Engineer*. (22 April 1957)

P. S. Nielsen, A.N.C.R.T., *Technologist*. (1 October 1958)

S. N. Angove, A.N.C.R.T., A.I.R.I., A.P.I., *Technologist*. (26 August 1959)

R. C. H. Hsia, B.Sc., Ph.D., *Chemist*. (2 January 1953) On study course in England.

S. J. Tata, B.Sc., *Assistant Chemist*. (14 December 1953)

ST. Sethu, B.E.(Chem)., M.Sc., *Assistant Chemical Engineer*. (1 September 1955)
On study course in England until 18 August 1959.

A. Karunakaran, B.Sc., *Assistant Biochemist*. (25 November 1957)

N. M. Pillai, B.A., F.I.C.S., *Assistant Chemist*. (29 October 1958)

Mrs R. Pepper, B.Sc., M.Sc., *Microbiologist* (Temporary appointment, 2 January 1959)

Yeo Oon Keong, B.Sc., *Assistant Chemist*. (5 October 1959)

SMALLHOLDERS' ADVISORY SERVICE DIVISION

J. M. F. Greenwood, B.Sc., (Agric.) *Smallholders' Advisory Officer*. (25 November 1948)

Shamsuddin bin Yub Ahmad, B.Agr., *Assistant Smallholders' Advisory Officer*. (23 October 1955). Seconded to Federal Land Development Authority until 1 May. Resigned 22 September 1959.

J. G. Samuel, B.Sc., (Agric.), *Assistant Smallholders' Advisory Officer*. (1 May 1939)

Mohd Johar bin Mohd Rashid., *Assistant Smallholders' Advisory Officer*. (1 August 1958)

Wong Mun Yun, *Assistant Smallholders' Advisory Officer*. (1 January 1959)

ESTATES ADVISORY SERVICE

L. R. Davidson, B.Sc. (Agric.) *Head of Service*. (1 December 1940)

Lim Poh Loh, *Assistant Advisory Officer*. (6 April 1959)

ACCOUNTS, 1959

BALANCE SHEET A

LIABILITIES						31.12.59	As at 31.12.58
					\$ c.	\$ c.	\$
SUNDRY CREDITORS							
Staff	...	...	...	...	74,422.16		
Merchants	...	...	...	...	465,261.09		
Miscellaneous	...	...	...	...	23,055.45	562,738.70	444.2
STAFF CONTINGENCY RESERVE FUND							
As at 31st December 1958	...	...	...	...		330,000.00	330,0
RESERVE FOR GRATUITIES FOR EQUALISATION OF PROVIDENT FUND CONTRIBUTIONS					—		50,1
Less Investments of these Funds in the Post Office Savings Bank	...	...	...	...	—		50,1
EXCESS OF ASSETS OVER LIABILITIES							
As at 31st December 1958	...	...	...	...	5,554,701.56		
Add Transfer of Reserve for Gratuities for Equalisation of Provident Fund Contributions	...	...	...	...	50,537.28		
					5,605,238.84		
Excess of Income over Expenditure for the year — Experiment Station	...	...	...	...	311,628.16		
					5,916,867.00		
Less Excess of Expenditure over Income for the year — Head Office	...	...	...	...	769,160.89		
					5,147,706.11		
Written off:							
Plant and Machinery	...	...	...	...	\$ 134,837.98		
Furniture	...	...	...	...	21,776.73		
Buildings	...	...	...	...	61,374.09	217,988.80	
					4,929,717.31		
Less Original Cost of Replanted Areas transferred from Experiment Station Development	...	...	...	...	25,307.13	4,904,410.18	5,554,7
Carried forward						5,797,148.88	6,329,0

AT 31 DECEMBER 1959

ASSETS					31.12.59	As at 31.12.58
LAND AND BUILDINGS						
2¼ Mile Compound		\$	c.		\$ c.	\$
Land as at 31st December 1958 ...	...	15,784.35				
198 and 200 Ampang Road:						
At Nominal Value ...	...	2.00			15,786.35	15,786
3rd Mile Compound						
Land as at 31st December 1958 ...	...	31,440.35				
251, 253, 255, 257, 259 & 261 Ampang Road:						
At Nominal Value ...	...	6.00			31,446.35	31,446
3½ Mile Compound						
Land as at 31st December 1958 ...	...	27,582.50				
262, 264, 266, 268 & 270 Ampang Road:						
At Nominal Value ...	...	5.00			27,587.50	27,588
4th Mile Compound						
Land as at 31st December 1958 ...	...	2,000.00				
74, 4th Mile Ampang Road:						
At Nominal Value ...	...	1.00			2,001.00	2,001
Eaton Road Compound						
Land as at 31st December 1958 ...	...	17,147.08				
1, 3, 5 & 7 Eaton Road:						
At Nominal Value ...	...	4.00			17,151.08	17,151
Wickham Road & Ridley Close						
Land as at 31st December 1958 ...	...	43,623.50				
9 Bungalows — At Nominal Value ...	...	9.00			43,632.50	43,633
Ukay Heights						
As at 31st December 1958 ...	...	1,515.00				
Additions during the year ...	...	102,894.39			104,409.39	1,515
Ulu Klang						
Land as at 31st December, 1958 ...	...	7,705.00				
Workmen's Quarters — At Nominal Value ...	...	1.00			7,706.00	7,706
Ampang Road Laboratories						
As at 31st December 1958:						
Land ...	...	19,526.00				
Buildings ...	...	8,699.68				
		28,225.68				
Additions during the year ...	...	359,390.71			387,616.39	28,226
Sungei Buloh Laboratories & Houses						
Laboratories as at 31st December 1958 —						
At Nominal Value ...	...	1.00				
Additions during the year ...	...	93,696.32				
		93,697.32				
Houses as at 31st December 1958 —						
At Nominal Value ...	...	24.00			93,721.32	25
Carried forward					731,057.88	175,077

	31.12.59	As at
	\$ c.	31.12.59
Brought forward	5,797,148.88	6,329,0

Carried forward	5,797,148.88	6,329,0
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		31.12.59 \$ c.	As at 31.12.58 \$
	Brought forward	731,051.88	175,077
Land & Quarters for Rubber Instructors (under Construction)			
As at 31st December 1958:			
Land	9,627.50		
Quarters	73,342.18		
	<u>82,969.68</u>		
Additions during the year	87,841.83		
	<u>170,811.51</u>		
Less Written off	61,374.09	109,437.42	82,969
Pilot Instruction Centre			
As at 31st December 1958:			
Land	8,297.94		
Buildings	1.00	8,298.94	8,299
PLANT AND MACHINERY			
As at 31st December 1958	121,580.23		
Additions during the year	23,527.63		
	<u>145,107.86</u>		
Less Written off	134,837.98	10,269.88	121,580
FURNITURE			
Residential Houses, Kuala Lumpur			
At Nominal Value		1.00	1
Quarters for Rubber Instructors			
At Nominal Value		10.00	10
Sungei Buloh			
At Nominal Value		1.00	1
Offices, Kuala Lumpur			
As at 31st December 1958	1.00		
Additions during the year	21,776.73		
	<u>21,777.73</u>		
Less Written off	21,776.73	1.00	1
Library			
At Nominal Value		1.00	1
Laboratories			
At Nominal Value:			
Kuala Lumpur	1.00		
Sungei Buloh	1.00	2.00	2
	<u>2.00</u>		
Carried forward			
		859,080.12	387,941

	31.12.59	As at
	\$ c.	31.12.58
Brought forward	5,797,148.88	6,329,000.00

Carried forward	5,797,148.88	6,329,000.00
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						31.12.59	As at 31.12.58
						\$ c.	\$
Brought forward						859,080.12	387,941
APPARATUS AND GLASSWARE							
At Nominal Value						1.00	1
MOTOR VEHICLES							
At Nominal Value						1.00	1
WORKSHOP							
At Nominal Value						1.00	1
LIBRARY BOOKS AND PERIODICALS							
At Nominal Value						1.00	1
EXPERIMENT STATION DEVELOPMENT							
As at 31st December 1958						2,908,779.89	
Additions during the year						691,242.69	
						3,600,022.58	
Less Government Rubber Replanting Scheme							
Grants						\$ 23,160.00	
Original Cost of Replanted Areas						25,307.13	
						48,467.13	3,551,555.45
							2,908,780
STOCKS							
Petrol, Oil & Chemicals							
Head Office						190.97	214
Experiment Station						9,251.26	2,988
Empty Containers & Drums							
Head Office						133.00	165
Experiment Station						4,811.10	200
Stationery							
Head Office						4,533.76	11,207
Sundry Materials							
Head Office						15,628.57	14,834
Experiment Station						9,787.64	20,709
Rubber							
Experiment Station						58,543.35	50,910
							101,227
SUNDRY DEPOSITS						310.00	295
Carried forward						4,513,829.22	3,398,247

	31.12.59	As at 31.12.59
	\$ c.	\$
Brought forward	5,797,148.88	6,329,000.00

REPORT OF THE AUDITORS TO THE BOARD OF THE RUBBER RESEARCH INSTITUTE OF MALAYA

We have examined the above Balance Sheet with the books and vouchers of the Institute and have obtained all the information and explanations we have required.

Titles to certain of the Institute's lands have not yet been issued.

Subject to the foregoing, in our opinion, the said Balance Sheet is properly drawn up so as to exhibit a true and correct view of the state of the Institute's affairs at 31 December 1959 according to the best of our information and the explanations given to us and as shown by the books of the Institute.

Kuala Lumpur
March 1960.

Sgd Peat, Marwick, Mitchell & Co.
Chartered Accountants
Auditors

5,797,148.88	6,329,000.00
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						31.12.59	As at	
						\$ c.	31.12.58	
						\$	\$	
SUNDRY DEBTORS						Brought forward	4,513,829.22	3,398,247
Staff								
Loans for Motor Vehicle Purchase						286,534.96		262,026
Travelling and Sundries						59,966.54		31,689
						346,501.50		
General								
Head Office						\$181,992.87		106,772
Experiment Station						276.90	182,269.77	8,022
Interest Accrued on Investments						3,674.65		3,806
Payment in Advance								
Head Office						4,848.61		28,604
Experiment Station						7,047.50	11,896.11	7,836
							544,342.03	
								448,755
LOCAL AND BRITISH GOVERNMENT SECURITIES								
(Held for account of Staff Contingency Reserve Fund)								
\$ 15,000/- 4½% Singapore Municipal Debenture Stock 1930-70/80 (\$17,537/-†) (\$11,737/-*)						15,000.00		15,000
\$ 40,000/- 3% F.M.S. Govt. War Loan 1940-52/59						‡		40,000
\$160,000/- 5% Malayan Union Govt. Loan 1946-62/66 (\$160,000/-†) (\$134,596/-*) ...						160,000.00		160,000
£ 20,600/- 3½% British War Loan 1952 (\$145,322/-†) (\$113,379/-*)						145,322.05		145,322
\$ 40,000/- Federation of Malaya 5½% Regd. Stock 1979/82 (\$40,000/-†) \$40,000/-*) ...						40,000.00	360,322.05	—
† Original Cost — \$362,859/-								
* Market Value as at 31st December 1959 — \$299,712/-								360,322
‡ Converted into Federation of Malaya 5½% Regd. Stock 1979/82.								
CASH AT BANK AND IN HAND								
At Bank — Current Account						371,480.46		
In Hand						7,175.12	378,655.58	2,121,743
							5,797,148.88	6,329,067

Income & Expenditure Account (excluding Experiments)

EXPENDITURE										31.12.59	Year 1 31.12.58
To										\$ c.	\$
International Rubber Research Board and International Rubber Development Committee										8,571.43	—
London Advisory Committee										46,203.58	28,431.10
Board Meetings										5,098.66	3,311.10
Salaries of Staff on Agreement											
Research — Division A								\$1,050,612.96			827,631.10
Research — Division B								168,158.64	1,218,771.60		128,311.10
Salaries of Staff not on Agreement									1,264,700.26		1,280,231.10
Provident Fund									230,472.67		217,511.10
Medical									40,696.50		34,911.10
Travelling									117,679.93		94,911.10
Office General Charges									73,631.01		55,711.10
Rents, Rates and Taxes									24,184.56		19,911.10
Insurance									30,171.65		27,211.10
Rentals									18,247.35		—
Laboratory General Charges									13,200.57		9,111.10
Buildings and Grounds									176,192.04		182,211.10
Furniture and Office Equipment									60,420.13		45,711.10
Fixtures and Fittings									55,683.93		46,411.10
Plant and Machinery									85,189.17		108,611.10
Vehicles Maintenance									13,578.63		21,311.10
Workshop									17,151.13		14,811.10
Apparatus and Glassware									214,446.05		161,311.10
Laboratory Chemicals									43,486.35		30,911.10
Publications									51,421.29		83,911.10
Library (Books and Periodicals)									28,212.31		19,211.10
Exhibitions									4,896.11		2,411.10
Smallholders' Advisory Service									776,303.04		644,311.10
Field and Factory Experiments									111,507.96		115,311.10
Technical Classification									24,278.09		23,811.10
Gratuities to Staff									56,518.96		319,011.10
Leave Pay									—		102,111.10
Passages									159,948.33		102,611.10
Grant towards Passages									1,784.34		1,501.10
Scholarship									7,998.00		6,611.10
Excess of Income over Expenditure									4,980,645.63		4,760,311.10
									—		1,524,711.10
									4,980,645.63		6,285,111.10

Income & Expenditure Account for Experimen

[illegible]

Station) for the year ended 31 December 1959

INCOME										31.12.59	Year to 31.12.58
										\$ c.	\$
By	Contributions received from The Malayan Rubber Fund									4,113,128.00	6,193,980
	Publications Sold									40,933.14	16,032
	Rents on Houses									3,223.43	17,402
	Interest on Loans									3,637.70	4,072
	Interest on Investments									21,695.66	23,136
	Miscellaneous									28,866.81	30,538

Total area 2979 acres

DISTRIBUTION OF EXPERIMENTS BY DIVISIONS

Mainly large and small-scale clone trials, seedling trials and hand pollination trials.

Experiments with tapping methods, density of planting, propagation methods, cover crops and other trials.

Nurseries.

